IMPACT OF GROWTH ENHANCEMENT SUPPORT SCHEME ON PRODUCTIVITY, WELFARE AND INCOME DISTRIBUTION OF SMALLHOLDER MAIZE FARMERS IN KANO STATE, NIGERIA

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EXTENDED ABSTRACT

In an effort to unlock the productive potential of the agricultural sector in Nigeria, in 2011 the government implemented the Growth Enhancement Support Scheme (GESS) in all the thirty six states of Nigeria including Abuja Federal Capital Territory. GESS is an innovative input subsidy programme that uses phone technology to reach farmers directly with subsidized fertilizer and improved maize seeds. The overall objective of GESS programme was to raise the productivity of millions of smallholder farmers and bring them out of poverty while providing wider food security. Available empirical evidence on the effectiveness of GESS in achieving these objectives across the country is mixed, suggesting more empirical studies. This study contributes to literature on impact of farm input subsidy programme's by examining the impact of GESS on productivity, welfare and income distribution of smallholder maize farmers in Kano state. The study adopted a cross-sectional research design and a two-stage sampling with stratification was used to draw a representative sample of GESS participants and non-GESS participants for the study. A total of 170 GESS participants and 220 non -participants were sampled across the state to address three objectives: (i) to examine the impact of GESS on maize productivity of smallholder farmers in Kano state, (ii) to examine the impact of GESS subsidy programme on welfare of the smallholder maize farmers in Kano State and finally, (iii) to examine the impact of GESS on income distribution of smallholder maize farmers in Kano state. The study employed Propensity Score Matching (PSM) and Instrumental Variable (IV) method to address objective one, while Propensity Score Matching and Binary logistic Regression with Instrumental Variable Method were used to address objective two and conditional Instrumental Variable Quantile Treatment Effect Model (IV-QTE) was used to address objective three. The result from the impact of GESS on maize productivity indicated that GESS significantly increased maize yield of participants by 37.7% (p ≤0.05¿ . Other factor that were positive and significantly correlates with

maize productivity were membership to commodity associations, years of education, household size and age of household head while distance to farm correlates negatively with maize productivity. The results from the impact of GESS on household welfare show that the incidence of multidimensional poverty of the sampled population was high (64%). Implying that on average, 64% of the sampled population were multidimensional poverty index poor (MPI poor). While the incidence of multidimensional poverty of GESS participants was 59%, the mean MPI intensity was 0.45 and multidimensional poverty index was 0.29. The result from PSM indicates that GESS significantly decreased household multiple deprivation within the range of -0.05 to -0.06 depending on the matching method used. While the result from the binary logistic regression with instrumental variable method indicates that GESS subsidy decreased the probability of households to be MPI poor by 16.8 percentage points at $p \leq 0.1$, indicating that the impact of GESS programme on MPI was weak. The findings also show that off farm income, market participation, age of household head, education level and membership of commodity association negatively influence MPI. These factors ought to be accorded priority in subsequent design of poverty reduction programmes in the future. The results from IV-QTE shows that the impact of GESS subsidy was statistically higher at the lower tail of income distribution and the fraction of the poor who benefited more from the GESS programme vary by age, years of education, market participation and area cultivated. The results suggest that GESS subsidy was pro-poor with respect to farmers' income. Overall, the findings of the study suggest that although GESS subsidy improved average productivity, it had little effect on farmers' welfare. Improving the distributional outcome of the programme by effective targeting of vulnerable and poorer households would maximize programme's contribution to food security, farmers' income and poverty reduction. The study recommends that further research should focus on the estimation of overall increase in maize production as a result of GESS and to determine whether total benefits outweighs the costs.

DECLARATION

I, **Tiri Gyang Dakyong,** do hereby declare to the Senate of Sokoine University of Agriculture that this thesis is my own original work done within the period of registration and that it has neither been submitted nor is it being concurrently submitted in any other institution.

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LIST OF ABBREVIATIONS AND ACCRONYMS

ADP	Agricultural Development Project
AE	Adult Equivalent
ATA	Agricultural Transformation Agenda
ATA-SP	Agricultural Transformation Agenda –Special Programme
ATE	Average Treatment Effect
ATT	Average Treatment on the Treated
ATU	Average Treatment on the Untreated
DMTV	Drought Resistant Maize Variety
EA	Enumeration Area
FAO	Food and Agricultural Organization
FEPSAN	Fertilizer Producers and Suppliers Association of Nigeria
FMSP	Fertilizer Market Stabilization Programme
FMARD	Federal Ministry Agriculture Rural Development
FISP	Farm Input Subsidy Programme
GESS	Growth Enhancement Support Scheme
GA	Grow Africa
HDI	Human Development index
IDEP	International Department for the Eradication of Poverty
IFDC	International Fertilizer Development Corporation
IITA	International Institute for Tropical Agriculture
ISP	Input Subsidy Programme
IV	Instrumental Variable
IV-QTE	Instrumental Variable Quantile Treatment Effect
KNARDA	Kano Agricultural and Rural Development Agency
KBM	Kernel Bandth Matching
LPM	Linear Probability Model
MPI	Multidimensional Poverty Index
NAIVS	National Agricultural Input Voucher Subsidy
NBSN	National Bureau of Statistics of Nigeria
NERICA	New Rice for Africa
NNM	Nearest Neighbour Matching
NPK	Nitrogen Phosphorus and Potassium
NIMC	National Identity Management Commission

NFI	Non -Farm Income
NPC	National population Commission
NPK	Nitrogen. Phosphorus and Potassium
OFI	Off- Farm Income
OPHI	Oxford Population and Human index
PDP	Peoples Democratic Party
PSM	Propensity Score Matching
RCM	Radius Caliper Matching
SAP	Structural Adjustment Programme
SSA	Sub-Saharan Africa
TSLS	Two Stage Least Square
UNDP	United Nations Development Programme
USD	United States Dollar
WB	World Bank

THESIS STRUCTURE

This thesis is presented in the format of publishable manuscripts consisting of five chapters. Chapter one consists of the general introduction which presents the background information on farm input subsidy programmes in Sub-Saharan Africa and growth enhancement support scheme (GESS), problem statement and justification of the study, objectives and conceptual framework which shows the link the objectives and the variables on the impact of GESS subsidy, productivity ,welfare and income distribution. Furthermore, the chapter presents a theoretical framework of upon which the study is underpinned. The chapter also presents the research methodology which cuts across all papers as well as scope and limitations of the study. Chapter two presents the first publishable paper manuscript. The paper manuscript evaluates the impact of GESS subsidy on productivity of smallholder maize farmers. This paper has been published in African Journal of Agricultural Research. Chapter three consists of the second publishable paper manuscript. This paper manuscript examined the impact of GESS on household welfare outcome of smallholder maize farmers in Kano state. Chapter four presents the third publishable paper manuscript. This paper manuscript evaluates the impact of GESS on the distribution of household income. Chapter five presents the key contributions of the study, general conclusions, and specific recommendations for policy in support of growth enhancement support scheme and areas for further research.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the Study

One of the overriding objectives of agricultural policies in developing countries is to increase smallholder productivity to meet household food security, increase net farm income and alleviate poverty. One approach to achieving this objective is using modern agricultural technologies such as fertilizer and improved seeds. Recognizing the importance of increasing the use of farm inputs in agricultural production, governments of different countries in Sub-Saharan Africa (SSA) adopted a number of policies intended to promote the use of modern farm inputs. At the centre of various policies adopted was subsidizing the prices of fertilizer and improved seeds paid by farmers (Adekunle *et al*., 2013). Agricultural input subsidies are a way of incentivizing farmers to purchase inputs that they are unable or unwilling to obtain at market rates (Dorward *et al*., 2014). Conventional arguments in supporting the implementation of farm subsidies in agricultural development have focused on the promotion of increased agricultural productivity through the adoption of new technologies (Ellis, 1992).

The use of farm input subsidy programme (FISP) to boost agricultural productivity and economic growth dates back to the 1960s during the Asian Green Revolution. The success of the green revolution in Asia was attributed to government support for subsidies, credits, improved infrastructure and uptake of technologies through research and extension (Hemming *et al*., 2018). Learning from Asia, Africa Green Revolution promoted universal farm subsidy programmes between the 70s and 1980s in order to increase agricultural productivity through increased use of improved seeds and fertilizers .The focus on

fertilizers and improved seeds were attributed to the need to increase production in the agricultural sector, given the political, economic, and social climate at the time (Kinuthia, 2020). Many African countries including Malawi, Tanzania, Kenya, Mozambique, Kenya, Ghana, Benin, Zimbabwe, Zambia and Nigeria implemented the universal subsidy programmes spanning for a period of five years and above (Druile and Barreiro-Haile, 2012; Shilvey and Ricker-Gilbert, 2013). Universal subsidies did not target specific crops or farmers with certain attributes, such subsidies were open to all farmers. However, experience with the universal subsidies in SSA was largely negative as it resulted in inefficiencies, such as poor targeting of programme beneficiaries (captured by influential or well-off farmers) and displacement of commercial sales (Morris *et al*., 2007). In addition, the cost of subsidy administration and budgetary allocation reduced the supply of critical public goods such as extension service, agricultural research, irrigation and road infrastructures across SSA (Morris *et al*., 2007).

Nigerian experience with the implementation of universal subsidy programmes was between 1976 and 2010, with their removal between 1986 and 1997 during the implementation of the structural adjustment programme. In 2000, fertilizer subsidy was reintroduced under the fertilizer market stabilization programme (FMSP). Under the FMSP, the federal governments procured fertilizer and distributed to states through sales agents and the agricultural development programmes (ADPs) (Nagy and Edun, 2002). However, political manipulations and poor subsidy administration lead to widespread reports of input diversion to neighbouring countries (Liverpool-Tasie and Takeshima, 2013). As a result there was low impact of programmes on productivity and wealth generation in the country. The market liberalization programme of the world bank did not improve the development of private input market, hence, fertilizer used stagnated at 8kg

per hectare .Average cereal yield decrease from 1800kg/ha to 1000kg/ha during the market liberalization programme (Amani *et al.,* 2010). Moreover, rural poverty increased from 33.6% in 2004 to 48.3% in 2010 (NBSN, 2010).While the country's food import bill rose to more than $11billion annually (FMARD, 2011).

In an effort to reverse this decreasing trend in low input use and low crop productivity, input subsidies were reintroduced again in 2011 under the Growth Enhancement Support Scheme (GESS). The broad objective of GESS was to increase farm level productivity, food security and farmers income by increasing fertilizer use from 13kgha to 50kgha (Liverpool-Tasie, 2013; Liverpool-Tasie and Takeshima, 2013). GESS was implemented with the intention of improving the efficiency of input distribution to smallholder farmers by minimizing leakages in input distribution that was common with the universal past subsidy programmes in Nigeria. It is termed a smart[1] or targeted subsidy because it relied on innovations and institutions to reach smallholder farmers with fertilizers and improved seeds. In addition, the main policy stance underpinning the implementation of GESS was the withdrawal of the state from direct involvement in the procurement and distribution of subsidized farm inputs in order to promote efficiency in input the delivery of subsidies and to simultaneously encouragement the development of the private input markets (Ibrahim *et al*., 2018). The GESS programme focused on the provision of fertilizer and seed subsidies to poor farmers. The focus on fertilizers and seeds was attributed to the need to rapidly increase food production in the sector, given the political, economic, and social climate at the time. These inputs are unaffordable to the small farmers, and government subsidies for such inputs are expected to increase agricultural production.

1 A smart subsidy is defined based on the efficiency of targeting. In particular, smart refers to subsidies that work to create demand for commercial fertilizer and seed as opposed to those that have a crowding out effect. The smartness of GES is mostly based on its innovativeness in terms of using mobile-based e-vouchers (Wossen *et al*., 2017; Reuben and Adams, 2020)

GESS leveraged on the private sector's participation to import and sell improved maize seeds and fertilizer to farmers at subsidized prices. In 2014, GESS recruited 1000 private agro- dealers and 14.5 million farmers registered through the e-wallet system (FMARD, 2014). Registered farmers were targeted with 2bags of 50kg fertilizers (NPK and Urea) and 25kg bag of improved Drought Resistant Maize Variety which is only sufficient for one plot of maize (Bello *et al*., 2012). Since more than 70% of 192 million Nigerians are employed in agriculture and are mostly small farm holders (FAO, 2011) any increase in productivity would reduce food insecurity and poverty in the state.

Many studies have examined the effect of input subsidies in the context of SSA. For example (Holden and Lunduka, 2012; Holden and Lunduka *et al*., 2013; Jayne and Rashid, 2013) for Malawi (Mason and Ricker-Gilbert, 2013; Mason *et al*., 2013) for Zambia and (Liverpool-Tasie, 2013) for Nigeria. While some argued that subsidies leads to economic inefficiencies and welfare losses as a result of market distortions others argued that subsidies are largely based on input market imperfections (Lunduka *et al*., 2013; Jayne *et al*., 2013; Ricker-Gilbert *et al*., 2013). Regardless of the potential benefits of subsidies, there is ongoing debate regarding the effectiveness and efficiency of subsidy programmes in Sub-Saharan Africa (Kato, 2016). Subsidies in any form have been widely criticized as inefficient means of allocating scarce public resources. For example, in a recent study, Gilbert (2020) found that not all countries in SSA have been able to increase uptake of improved seeds and inorganic fertilizer, and that input subsidy programmes have not achieved their goals. In addition, the political nature of input subsidies make it difficult to remove them once implemented, thereby constraining growth in agricultural sector (Jayne and Rashid, 2013; Jayne *et al.,* 2018) cited by Kinuthia (2020). While (Basurto *et al*., 2020) argued that input subsidies create a competitive platform through

which private sector engagement is improved, allowing for efficiency in the allocation of resources to the poor (Basurto *et al*., 2020). Lunduka *et al.* (2013) lauded farm input subsidies for being channels for boosting food production (Lunduka *et al.,* 2013). Jayne *et al*. (2018) found that input subsidy programmes in SSA increase production in the short run but production and welfare effects were quite low in the long run. In some cases subsidies have been found to increase crop diversification (Holden and Lunduka, 2012) and reduced the gender gap (Fisher and Kandiwa, 2014). In this regard, the introduction of input subsidies is a step towards achieving food security and poverty reduction (Jayne *et al*., 2018; Jayne and Rashid, 2013). Studies by Ricker-Gilbert *et al*. (2011) in Malawi, Shilvey and Ricker-Gilbert (2013) in Malawi. Hepelwa *et al*. (2013) used panel data set for 2008 and 2002 to conduct a study on the effectiveness of the fertilizer voucher programme in Tanzania and found double increase in crop yields. While Ray (2019) also found that the Tanzanian NAIVS programme increased crop yield and net farm revenue. On the contrary (Kato, 2016; Gine *et al*., 2019) did not find any impact of NAIVS programme on agricultural productivity and household welfare in different regions of Tanzania. There seems to be no consensus on the effectiveness of farm input subsidy programme. Therefore, this study focused on the question: what are the impact of GESS subsidy programme on maize productivity and farmers' welfare in Kano state, and is the impact of GESS subsidy on the distribution of households' income the same among the farmers?

The study focused on productivity and welfare outcomes as they are the most important indicators given the stated objectives of the GESS. We use a counterfactual framework and econometrical methods to identify the impact of GESS subsidy on maize productivity and household welfare and a quantile treatment effect framework was used to examine the

distributional impact of GESS on smallholder maize farmers. Unlike other studies, we applied a non-separable farm household model which assumes that due to market imperfections, GESS subsidy programme affects both farmers production and consumption decisions of the farmers, which is prevalent in developing countries (Dillion and Barrett, 2017; LeFave and Thomas, 2016). The model views the households as single entities which is constrained by resources and make joint and collective allocation decisions to maximize a common utility or welfare function. We measure maize productivity in terms of yield per hectare; while household welfare was measured in terms of Multidimensional Poverty Index (MPI).

This study intends to contribute to this debate on the effectiveness and efficiency of farm input subsidies by evaluating the impact of GESS subsidy on the productivity and welfare of poor and food insecure households in Kano State. Understanding the impact of GESS subsidy is important so that recommendations can be made to the government on areas that can improve the effectiveness of the programme. The findings will inform any future efforts to implement agricultural subsidy programmes in Nigeria. Furthermore, the study will also add an important dimension to the emerging literature on the debate on farm input subsidy programmes in SSA.

1.2 An overview of Growth Enhancement Support Scheme in Nigeria

Nigeria's agricultural sector is the mainstay of its economy; accounting for approximately 38 per cent of its gross domestic product and 65 per cent of employment (World Bank, 2019). Between 1976 and 2010, the country faced implemented eight different farm input subsidy programmes. All subsidy programmes were marred by political manipulations and poor subsidy administration leading to widespread report of input diversion and

leakage with negative consequence of the fertilizer input market (Nagy and Edun, 2002). Moreover rural poverty measured at food poverty line increased from 33.6% in 2004 to 48.3% in 2010 (NBSN, 2010). The country's status changed from a food exporter to one of the world's largest importer of food, spending more than $11billion annually (Adeshina, 2012) cited by Wossen *et al*. (2017). This prompted the Nigerian government to introduce agricultural support measures to remedy the situation. This gave rise to the Growth enhancement Support Scheme in 2011. GESS subsidy was designed to reduced leakages in the distribution of subsidized inputs only to intend farmers by increasing fertilizer use from 13 kg/ha to 50 kg/ha (FMARD, 2011; Olomola, 2015; Omotayo *et al*., 2017). In Growth Enhancement Support Scheme (GESS), mobile phones are used to reach with fertilizers and improved seeds (Nwalieji *et al.*, 2015; Adabara *et al.,* 2017). The programme focused on farmers who had little or no experience of using improved seeds and inorganic fertilizers over the previous years. GESS leveraged on the private sector's participation to import and sell seed and fertilizer to farmers at subsidized prices. The intention is to ensure that GESS is market driven and private sector friendly (Olomola, 2015).

Farmers were registered into GESS based on clearly defined selection criteria. A registered farmer should not be less than 18 years of age and must be resident in the village for not less than ten years and must own a phone. Also, a registered farmer must own three or less than three hectares of land in the village (Mortilewa *et al.,* 2015). A list of registered farmers was compiled at the initial stage at the village level and was transferred to a national electronic database. The registration of farmers was done manually at village level with the help of village leaders (Olomola, 2015). The village leaders who used their own perception to determine who were the poor, needy and

deserving farmers but in some cases, the selection was made through voluntary registration and by the village leaders in the village (Olomola, 2015) cited by Wossen *et al*. (2017). Moreover, each farmer was given a unique identifier with the help of National Identity Management Commission (NIMC). After registration was completed, eligible farmers received an electronic voucher notification through their phones. The e-wallet specifies fix quantity of fertilizer and improved seed allocated to the farmer as well as the designated redemption center for collection. The vouchers were redeemable with a 50 per cent subsidy by paying the difference between the market price of inputs and the face value of the voucher (Olomola, 2015). Although there was no database to verify farmer's eligibility, most of the socio-demographic information provided by farmers was self-reported (Wossen *et al*., 2017). By design, GESS was expected to provide improved seeds and fertilizer to 20 million farmers in four cohorts within five years in the first phase (FMARD, 2011). In 2014, 1000 agro-dealers and fourteen million five hundred farmers were registered on the electronic wallet system and about one million two hundred farmers had received inputs through the electronic-wallet system. (Agboola and Agboola, 2015) cited by Micheal *et al*. (2018) reported that under GESS subsidy, Nigerian public spending on fertilizer subsidies increased from #13.30 billion (USD84.44 million) in 2012 to #82.38 billion (USD519.57) in 2014 and in 2015 alone, #26Billion (USD 134million) was spend on the procurement and distribution of fertilizers to farmers across the country.

1.3. Problem Statement and Study Justification

There is empirical evidence on the positive impacts of farm input subsidy programmes on smallholder productivity and households' welfare in SSA. For example, Ricker-Gilbert *et. al*. (2011) in Malawi, Shilvey and Ricker-Gilbert (2013) in Malawi, Similarly, studies on the impact of GESS subsidy programme in different states in Nigeria have reported

positive impact on agricultural productivity. For example Oyediran (2015); Nwalieji *et al.* (2015) in Imo, Ememchukwu (2017) in Anambra, Adenegan *et al.* (2018) in Oyo;; Oguniyi *et al*. (2017) in Oyo, Ogun and Osun states, Ogunniyi *et al*. (2018) in Oyo and (Ibrahim *et al.*, 2018) in Katsina. All these studies applied similar methods on cross-sectional data to address sample selection bias and potential endogeneity in order to estimate the impact GESS subsidy on productivity in different parts of Nigeria, results from the studies indicated that while the direction of its effect on maize yield in general is positive, quantitative effects are not the same, justifying location specific studies. This study contributes to the impact evaluation literature on the impact of FISP on productivity and welfare of smallholder maize farmers with evidence from Kano state, Nigeria.

In addition, some studies that have evaluated the impact of farm input subsidy programmes on household welfare such as (Mason and Smale, 2013 in Malawi, Awotide *et al*. (2013); Oguniyi *et al*. (2017) ; Wossen *et al*. (2017) in Nigeria, Adenegan *et al*. (2018) in Oyo state used income poverty as a measure of welfare. Income poverty considers income based on money measures while poverty is a multidimensional phenomenon which comprised of many interlocking factors, therefore a single indicator such as income is not able to accurately capture the multidimensional aspect of poverty (Alkire and Santos, 2014; Burchi *et al.*, 2018). In recent time, a growing number of studies have emerged around multidimensional poverty measures. One approach in particular is the Alkire and Foster (AF) method of calculating the Multidimensional Poverty Index (MPI). The MPI method is considered to be a better measure of poverty because it captures wider indicators of poverty such as household assets, nutrition, health and education, which contributes towards improving the quality of life experienced by members within the household. Only a few impact evaluation studies have adopted the

MPI method of evaluating poverty (Burchi *et al.*, 2018; Song and Imai, 2019; Isinika *et al*., 2020), highlighting the need for further research on how the AF method of MPI can be used in impact evaluation studies. Therefore, this study contributes to literature by evaluating the impact of FISP, but also to poverty as a multidimensional phenomenon. Specifically, the study examined the direct impact of GESS input subsidy on multidimensional poverty index as a measure of household welfare. The findings of this study have implication for effective design of welfare programmes.

It is important to know that the impact of GESS subsidy can vary when certain group of households' benefits more than others from the programme, In view of this, the study examined the impact of GESS on the distribution of household income. GESS specifically targeted smallholder farmers on the lower tail end of the productive assets, how well GESS impacts participants across the distribution of income have implication for avoiding rising inequality and effective targeting. The overall research question of this study is: how does GESS subsidy programme impact maize productivity, welfare outcome and income distribution in Kano state. Therefore, this study addressed three specific research questions: (i) what is the impact of GESS input subsidy on maize productivity of participating households? (ii) What is the impact of GESS subsidy on the welfare of beneficiaries? (iii) Does the impact of GESS differ across the distribution of household income? To measure the impact of GESS on productivity, welfare and income distribution of smallholder maize farmers, we compare two groups (those in GESS programme and those not in GESS programme). The study focus on smallholder maize farmers who grow other crops. We observed both farm and nonfarm activity of the farmers to understand programme impact. We identify lessons for further improvement of the scheme.

Moreover, the findings of the study can be used as baseline information for future research.

1.4 Study Objectives

1.4.1 Overall objective

The overall objective of this study was to examine the impact of GESS subsidy programme on productivity, welfare and income distribution of smallholder maize farmers in Kano state, Nigeria.

1.4.2 Specific objectives

The specific objectives of the study were as follows:

i. To examine the impact of GESS subsidy programme on productivity of smallholder maize farmers in Kano state;
ii. To examine the impact of GESS subsidy programme on welfare outcome of smallholder maize farmers in Kano state;
iii. To examine the impact of GESS subsidy programme on income distribution of the smallholder maize farmers in Kano state.

1.4.3 Hypotheses of the study

Based on the research objectives of the study, the following hypotheses were established:

H_1: GESS subsidy programme has no effect on maize yield.

H_2: GESS subsidy programme has no impact on welfare of smallholder maize farmers.

H_3: GESS subsidy programme has no impact on income distribution of smallholder maize farmers.

1.5 Scope and Limitations of the Study

Limitations are matters and occurrences arising from a study which are out of the researcher's control; they limit the breadth and depth to which a study can reach (Simon and Goes, 2013). This study was carried out in Kano state North-west, Nigeria. The aim of the study, however, was to examine the impact of GESS on productivity, welfare and income distribution of smallholders maize farmers in Kano state, Nigeria. Observational data from a cross section survey were used. Analytical methods were used to address sample selection bias and potential endogeneity. The inventorization of farmers' income in Nigeria has always been problematic; most of the farmers do not keep records of their income and consumption expenditure. Hence, we acknowledged the challenge of computing household income from recall data.

Other limitations of the study were lack of uniform weighing of crops harvested and sold in the market; hence we encountered some measurement problems which may have affected our estimation of productivity and household income at household level. Although the researchers tried to probe to be able to translate weights into standard units some measurement errors may still exist. Notwithstanding the limitations of these limitations, the findings of the study provided empirical evidence regarding the impact of GESS subsidy, on productivity, welfare and income distribution of smallholder maize farmers in Kano State. Moreover, the study focused on the whole state making it easy to infer that the entire population of farmers were involved in the programme and the findings of the study can be generalized for the entire state.

1.6 Conceptual Framework

Fig 1.1 shows the pathways through which the GESS programme can impact farmers' productivity and welfare in Kano. Overall, we expect GESS subsidy programme to

influence welfare through the production –own consumption pathway and market-income pathway as seen in Fig. 1.1.

i. The immediate or direct impact of subsidized inputs will be on maize yield depending on household resources affecting productivity such as landholding, household size, and level of education and household characteristics such as household size in terms of labour, land area and farming experience affecting factor efficiency.

ii. Yield increase could improve household food security through increase in food consumption occurring through the own-production pathway.

iii Yield increase could enhance household cash income through crop and labour sells through the market-income pathway. Farmers will continue to grow maize for home consumption and selling maize for cash income while also selling labour off farm for wage income to smoothen household consumption.

iv The household cash income can be used to increase expenditure on food or non-food commodities such as education, health, household assets which improves the quality of life. Depending on the amount of income the household receives, it can be re-invested to self-finance farm production. Overall, we assume that GESS subsidy programme to influence welfare through the production –own consumption pathway and market-income pathway as seen in Fig. 1.1.

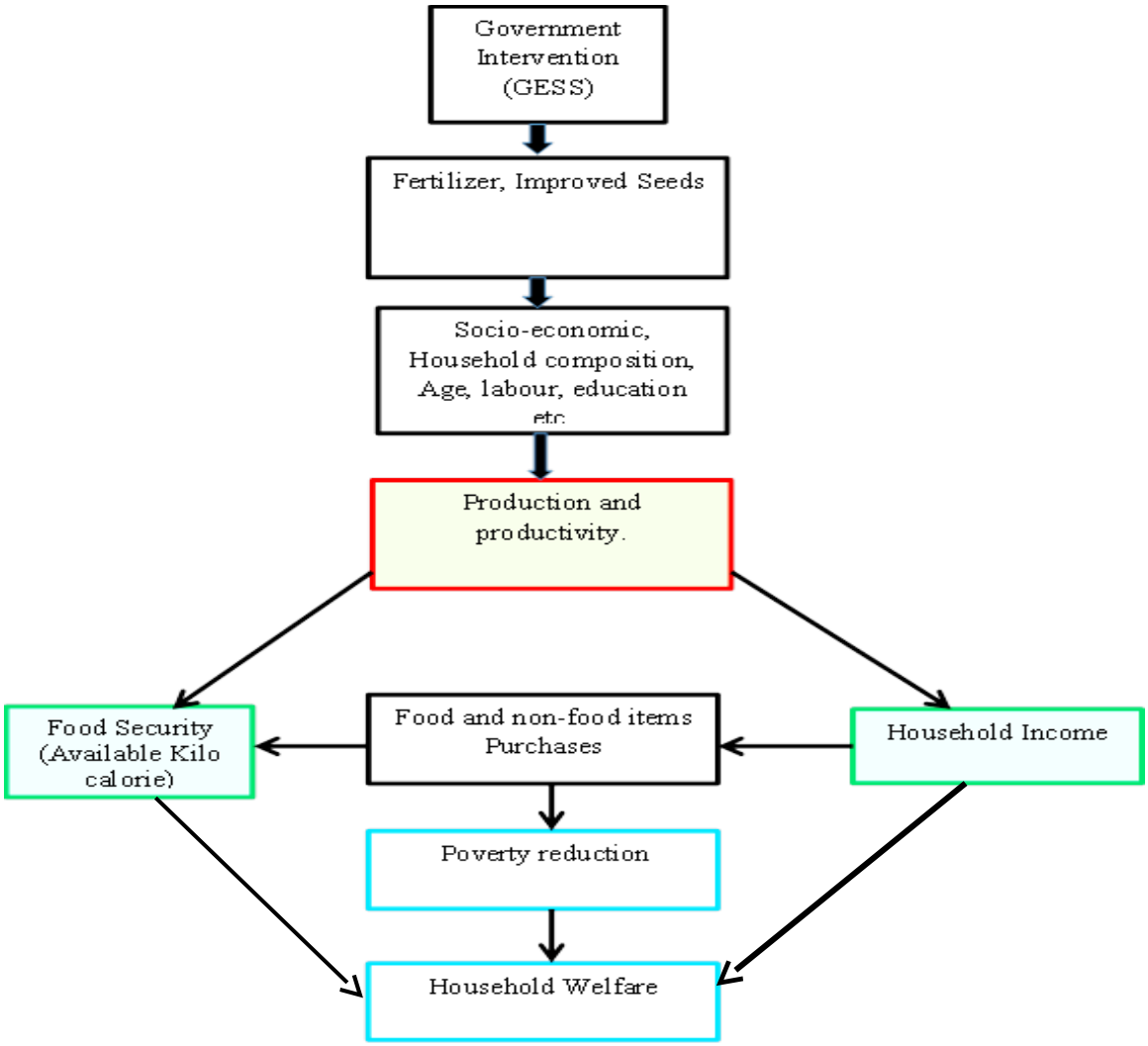

Figure 1.1: Conceptual framework showing the relationship between GESS subsidy programme, productivity, welfare and income distribution.

Source: Adapted from Eboh *et al.* (2006) and Nimako (2019).

1.7 Theoretical Framework

Farm-household theory

In this section, we apply the farm household model to show how GESS subsidy can influence farmers' production and welfare in Kano. Our analysis is based on the assumption of non-seperability of production and consumption decisions (Singh *et al.*,1986) and that farm inputs influence both decisions (Dillion and Barrett, 2017; Lefave and Thomas, 2016). The farm household model predicts how smallholders would behave presence of income, credits, input and transaction cost constraints as defined by Singh *et*

al. (1986); Sadoulet and de Janvry (1995). For example, in rural Nigeria, where financial markets are very thin and where villages are often isolated with limited access to various input and output markets, the production and consumption decisions are non-separable. The prices that guide decision making in input and output market are endogenously determined. The model views the households as single entities which is constrained by resources and make joint and collective allocation decisions to maximize a common utility or welfare function. Hence farmer's production and consumption is a constrained utility maximization problem (De Janvry *et al*., 2010). For example (Nantakyi-Frimpong, 2017; Amare *et al*., 2017; Nimako, 2019) derived production-consumption decisions from the in evaluating the impact of FISP on farmers welfare in Ghana and Nigeria respectively.

Under the assumption of non-seperability, the preferences for the farm households are defined by maximizing utility from maize produced , purchased goods and leisure subject to technology/production, income and time constraints as presented in equation 1, 2, 3 and 4 respectively;

$$U = U\left(Z_{a,} Z_{m,} C_l, Z^h\right) \quad \text{.....} \quad (1)$$

Where;

$U = ¿$ Household utility function (describing preferences)

$Z_{a,} = ¿$ Consumption of own production (Maize)

$Z_m = ¿$ Consumption of purchased goods

$C_l = ¿$ Labour supply

$Z^h = ¿$ Household consumption characteristics

S,t

$Q\left(Q_{a,}Q_{l,}Q_{X;}Z^{q}\right) = 0$ ……

(2)

Where:

Q = Production technology choice

$Q_{a,}=¿$ Quantity of food crop produced (maize)

$Q_{l,}=¿$ Labour used in maize production

$Q_{X;}$ = other variable inputs purchased and used in production (e.g. chemicals.)

$Z^{q}=¿$ Fixed production factors and producer characteristics

Given own production Z_a with price P_a and a purchase good Z_m with price P_m and consumption of leisure Z_l with price P_l with labour supply to farm Q_l with price w_l , P_X is price of other variable inputs Q_X used on the farm, l^s is time worked and (S) exogenous transfers (which includes remittances, off-farm income, savings).The farmers income (Y) is given by equation 3 assuming that the factor market is competitive and inputs are heterogeneous.

$P_X Q_X + P_m Z_m \leq P_a\left(Q_a - Z_a\right) + P_l\left(l^s - Q_l\right) + S$ …… (3)

The left hand side of equation 3 is consumption expenditure which is expected to be equal or less than income coming from marketed produce, labour wage and remittances. Therefore household expenditure must be equals to or less than income of the farmers.

The farm household allocates their time between leisure, on-farm and off-farm labour is given by equation 4. The opportunity cost of leisure is labour supply to farm production.

$E \leq l^s + C_l$ ……..... (4)

Where:

l^s = Available time worked

C_l = Time consumed on Leisure activities

E = Total time endowment.

The sum of time on farm, leisure and off –farm must not exceed the total time endowment.

Some of the farmers will be constrained in the labour market and, therefore, they might not be able to invest enough labour in agricultural production. The main source of income for the household will be on-farm income which comes from farm revenue less cost of wage payment to hired labour and the cost of inputs because most smallholder farmers sell their crops to be able to meet family expenses. Other sources of income are off-farm income and non-labour income such as profits, remittances and other transfers.

Given equation 1, the constrained utility maximization equation (marginal utility of full Income) is given by Lagrange multiplier (*λ)* as in equation 5.

$$Max_W = U + ¿\ \lambda\ \left[\left(P_c Q_c + S - P_x Q_x - P_m P_m \right) + \varnothing g + U_a \left(Q_a - C_a \right) + U_l \left(E - Q_l - C_l \right) \right] \quad \ldots(5)$$

Using decision prices of a, m and l, from first-order conditions of equation 5, the household's decision problem yields an input demand and output supply functions. The input demand function is a production/technology function expressed as in equation 6.

$$Q = Q\left(P^{¿} X, G, Z^q \right) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots$$

(6) The output supply function is a consumption function and is expressed as in equation 7.

$C = C\left(P^{¿}, Y^{¿} G, Z^{h}\right)$ ……..

(7) Where C a given level of consumption $Y^{¿}$ is the household level of endogenous income and $P^{¿}$ is are endogenous or decision prices affecting consumption. Q is the quantity of maize produced, Z^{q} are farm characteristics affecting production, while Z^{h} are household characteristics affecting consumption. G is quasi-fixed factor representing subsidized inputs while X is variable inputs purchased and used. The farm household would achieve a level of production (equation 6) before achieving a level of consumption (equation 7) depending on household income because consumption affects production decisions for households categorized as non-separable. This means that variables that affect consumption decisions (such as wealth, the household's total family labor endowment, consumer goods prices, and household characteristics) also affect production decisions. When the government decided to give subsidized inputs to households, it thus increased their on-farm incomes which can be used for different activities such as hiring labour, purchase of farm inputs increased expenditure on services that improves the household wellbeing.

1.8 Description of the Study Area

1.8.1 Location and physical features

The study was conducted in Kano State, Northwest, and Nigeria in 2017. Kano state is located in the North-west Geopolitical Zone of Nigeria, situated in the Sahelian geographical region, South of Sahara. It is found between latitudes 130^{0}N and 11^{0} S and longitudes 80^{0}N and 10^{0}E with a landmass of 20 760 km^{2}. The estimated average annual rainfall is between 700 and 1500 mm compared to the Southern regions that have tripled annual rainfall usually more than 2000 mm with an average annual rainfall is 700 mm and

35^0C and 19^0C as mean daily maximum and minimum temperatures in Kano (Mortimore, 1993).

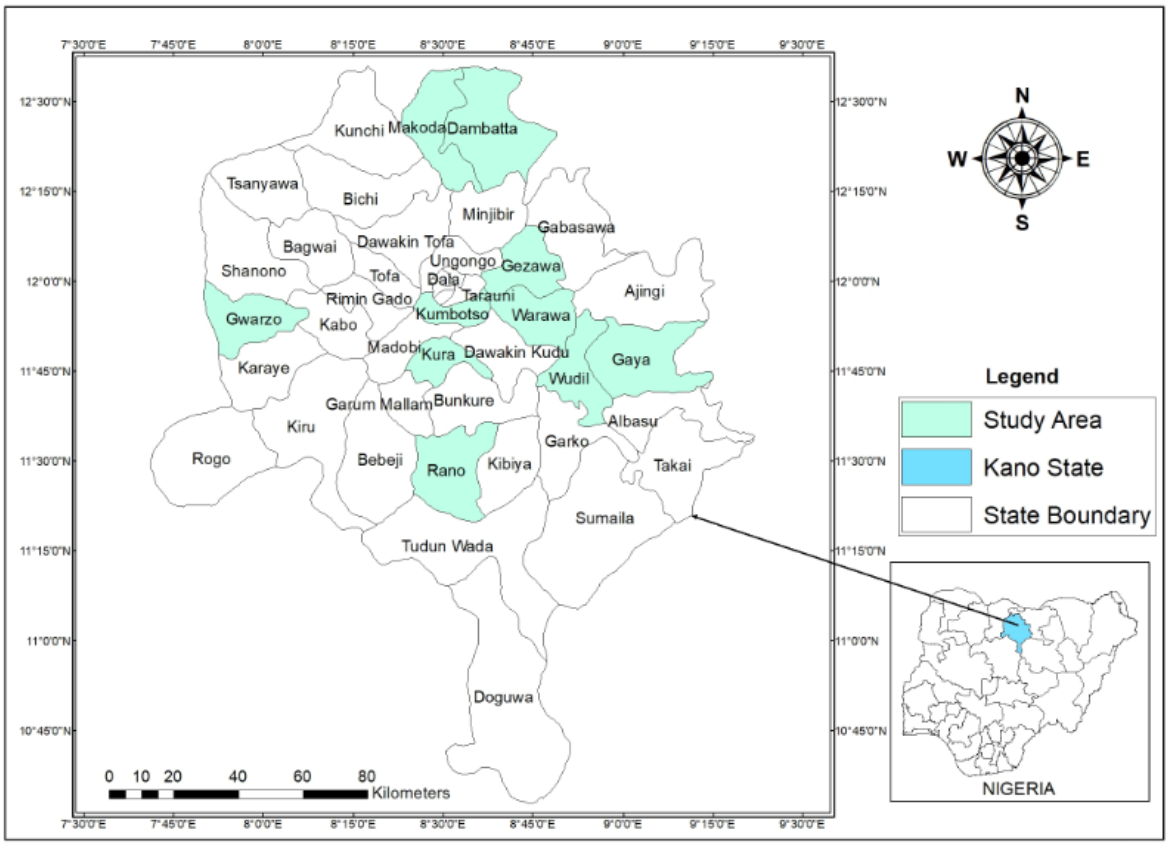

Figure 1.2: Map of Kano showing the sampled local government areas

Source: FUDMA GIS laboratory.

1.8.2 People and the economy

Kano state is the second largest state in Nigeria with 44 local governments. The state has a projected population of 11 206 688 million in 2012 based on 2.2% annual growth rate (Mohammed, 2017). The population of Kano is composed of people from different socio-cultural backgrounds who are engaged in different economic activities. The state has for several years been economically productive long before the advent of colonial rule. The indigenous/local populations are predominantly engaged in crop farming, livestock

rearing, and trading activities. There are also artisans with skills in different types of crafts that utilized the available natural resources to produce several goods that are required by many communities within and outside of the country (Mortimore, 1993). The people who practice agriculture are mostly peasant farmers who engaged in subsistence production typical of an agrarian society with majority producing arable crops (Ikejiofor, 1998). Maize, followed by rice, is the most-farmed crop in Kano. According to the government, maize occupies about 58 per cent of the area planted with crops, and rice occupies about 21.8 per cent (Mohammed, 2017). Other crops include sorghum, millet, cowpea wheat, roots, vegetables and cash crops such groundnut, and cotton. Maize accounts for about 55 per cent of the caloric supply of cereals, followed by rice and sorghum and millet. Although over 70% of the population relies on agriculture for survival, many have their hands on craft work and other off farm activities during the dry season.

The Human development index (HDI) which measures the overall achievement in the social and economic dimension of the people based on health, education, and wellbeing was estimated at 0.539 in 2016 which is higher than the national average of 0.532 (UNDP, 2016). While the 2019 subnational Global MPI report puts the Multidimensional poverty head count of Kano State at 0.40 and Multidimensional poverty index (MPI) at 0.33 (UNDP, 2019).

1.8.3 Sampling procedure and sample size

The study used Arkin and Coulton (1963) formula to draw a sample size from smallholder maize farmers in Kano state. It is given by equation 8

$$n=\frac{N Z^2 p(1-p)}{N d^2+Z^2 p(1-p)}$$

…….(8)

Where n = is the minimum sample size N = Total number of maize farmers made up of 3850 households, Z is confidence level (at 95% interval, Z=1.96) P is the estimated population proportion (0.50, this maximizes the sample size) d= error limit at 5% (0.05) which desired precision. The margin of error is a statistic expressing the amount of sampling error that is allowed. Based on the formula and the defined values for the elements of the formula, a sample size of 333 households was obtained. For the purpose of this study, a reserve of 20% was added to take care of non-response and failure to locate some sampled farmers for their response. This takes the sampled size to 390.

From a list of 138 villages collected from Kano Agricultural and Rural Development Agency (KNARDA). Three hundred and ninety maize farmers (390), which accounted for ten percent of 3850 target population of maize farmers were surveyed. The study employed a two-stage sampling design with stratification to draw a representative sample of GESS participants and non-GESS participants. In the first stage, 30 villages were randomly selected from 138 villages which comprise of the maize growing villages. While in the second stage a simple random sample of 390 households were selected by simple random sample and were stratified into 170 GESS farmers and 220 non GESS farmers. The list of GESS farmers and non GESS farmers was also collected from KNARDA. The list of sampled population can be seen in Table 1.1. Primary data were collected through face to face interview using a semi structured questionnaire. A semi-structured questionnaire is a mix of unstructured and structured questionnaires. Some of the questions and their sequence are determined in advance, while others evolve as the interview proceeds. The semi-structured interview allows respondents the freedom to express their views in their own terms. Data collected were on GESS status, regarding the impact of the scheme on household livelihoods outcomes like crop yields, income,

household assets, poverty status, food security status and socio economic characteristics. In addition, village-level data was collected on quantities and prices of farm inputs. However, inability to maintain the same population size for each stratum in the second stage violates sampling base on proportional to size thereby introduces chances of bias hence we acknowledge difficulties in selecting a truly representative sample (Table 1.1).

Table 1.1: Distribution of sample household heads based on local governments and villages

Local Governments	Villages Areas	Total number of households	Participants sampled	Non-participants sampled	Total sample
Wudil	Bange	105	6	9	15
	Buda	180	9	10	19
	Darki	112	6	9	15
Gaya	Amarawa	123	6	9	15
	Fani dau	199	6	9	15
	Kazurawa	197	8	8	16
Makoda	Dunawa	178	8	9	17
	Jibya	167	6	6	12
	Nakarari	159	5	7	12
Rano	Yado	164	6	6	12
	Yankanchi	180	8	10	18
	Zambur	157	5	9	14
Rogo	Gwangwan	156	4	9	13
	Kadafa	189	8	7	15
	Ruwan bago	145	3	6	9
Kura	Gamadam	145	4	8	12
	Gundutse	237	6	9	15
	Kunshama	170	7	8	15
Gezawa	Badan	165	6	3	13
	Bujawa	138	4	7	9
	Dan madanho	179	5	4	9
Kumbotso	Challawa	102	5	8	11
	Danbare	156	5	7	12
	Dangwauro	107	6	6	12
Danbatta	Ajumawa	149	3	3	6
	Dungurumi	135	5	6	11
	Fogolawa	156	4	6	10
Garun malam	Chiromawa	113	4	9	13
	Jobawa	129	5	9	14
	Yadakwari	90	6	6	12
Total		**3850**	**170**	**220**	**390**

1.9 Summary of Analytical Tools

The study employed descriptive analysis using measures of central tendency (mean and median), standard deviation and frequencies to summarize and describe main features of the variables used to address the three specific objectives. For objective one the study employed Propensity Score Matching (PSM) and Instrumental Variable (IV) method implemented as two stage least squares (2SLS) (Adenegan *et al.,* 2018; Oguniyi *et al.*, 2017; Wossen *et al.,* 2017). Propensity score matching and Binary Logistic Model with Instrumental Variable method was used to achieve objective two (Adebayo *et al.*, 2016; Song and Imai, 2019).Conditional Instrumental Variable-Quantile Treatment Effect model (IV-QTE) was employed to achieve objective three (Diagne and Didier, 2013; Olagunju *et al.*, 2019).The details are treated under individual chapters where they are used.

References

Adabara, I., Sunusi, A. and Mbabazi, B. P. (2017). Mobile Applications and Agricultural Knowledge of Smallholder Famers in Kura Local Government, Kano State, Nigeria: *International Journal of Scientific Engineering and Science* 1(6): 47-51.

Adebayo, O., Olagunju, K. and Ogundipe, A. (2016). Impact of Agricultural Innovation on Improved Livelihood and Productivity Outcomes Among Smallholder Farmers in Rural Nigeria: *International Journal of Economics and Financial Issues* 6(4).

Adekunle, A. A., Ellis-Jones, J., Ajibefun, I., Nyikal, R. A., Bangali, S., Fatunbi, A. O. and Angé, A. (2013). Agricultural Innovation in Sub-Saharan Africa: Experiences from multiple stakeholder approaches. Accra, Ghana: Forum for Agricultural Research in Africa (FARA).

Adenegan, K. O. Fagbemi, F. Osanyinlusi, O. I. and Omotayo, A. O. (2018). Impact of the Growth Enhancement Support Scheme (GESS)'On Farmers' Income in Oyo State, Nigeria: *The Journal of Developing Areas* 52(1): 15-28.

Alkire, S. and Santos, M. E. (2014). Acute Multidimensional Poverty: A New Index for Developing Countries: *World Development* 59: 251–274.

Amani, A. A., Alamu, J. F. and Kudi, Y. M. (2010). Effect of Fertilizer Liberalization on Maize Production in Nigeria: *Journal of Development and Agricultural Economics* 2: 401-405.

Amare, M., Jennifer, D., Nathaniel, D. and Bakele, S. (2017). The Impact of Agricultural Productivity on Welfare Growth of Farm households In Nigeria: A panel Data Analysis. Partnership for Economic Policy (PEP), Cornell University, School of Applied Economics and Management, Ithaca, New York, 14853, USA.

Arkin, H. and Colton, R. R. (1963). *Tables for statisticians, New York: Barnes and Noble Books*, 2nd Edition, contributed by the National Library of Australia. 124pp.

Awotide, B. A., Karimov, A., Diagne, A. and Nakelse, T. (2013). The Impact of Seed Vouchers on Poverty Reduction among Smallholder Rice Farmers in Nigeria: *Agricultural Economics* 44(6): 647-658.

Basurto, M., Dupas, P. and Robison, J. (2020). Decentralization and Efficiency of Subsidy Targeting: Evidence from Chiefs in Rural Malawi'. *Journal of Public Economics* 185: 104047. https://doi.org/10.1016/j.jpubeco.2019.07.006.

Bello, O., Abdulmaliq, S., Ige, S., Mahamood, J., Oluleye, F., Azeez, M. and Afolabi, M. (2012).Evaluation of early and late/intermediate Maize Garieties for grain Yield Potential and Adaptation to a Southern Guinea Savanna Agro-ecology of Nigeria: *International Journal of Plant Research* 2: 14–21.

De Janvry, A., Dustan, A. and Sadoulet, E. (2010). Recent Advances in Impact Analysis Methods for Ex-post Impact Assessments of Agricultural Technology :Options for the CGIAR (Unpublished working paper). University of California-Berkeley. Retrieved on 19 August 2018.

Diagne, A., Adékambi, S. A., Simtowe, F. P. and Biaou, G. (2009). The Impact of Agricultural Technology Adoption on Poverty: The case of NERICA Rice Varieties in Benin". Contributed paper presented at the 27th Conference of the International Association of Agricultural Economists. August 16-22, 2009, Beijing, China.

Dillon, B. and Barrett, C. B. (2017). Agricultural Factor Markets in Sub-saharan Africa: an Updated View with Formal Tests for Market Failure. *Food Policy* 67(C): 64-77. https://doi.org/10.1016/j.foodpol.2016.09.01.

Dorward, A., Roberts, P. D., Finegold, C., Hemming, D. J., Chirwa, E., Wright, H., Hill, R. K., Osborn, J., Lamontagne-Godwin, J., Harman, L. and Parr, M. J. (2014). Protocol: Agricultural Input Subsidies for Improving Productivity, Farm Income, Consumer Welfare and Wider Growth in Low- and Middle-Income Countries: A Systematic Review. The Campbell Collaboration. [https://www.cabi.org/Uploads/CABI/about-us/Scientists%20output/Farmer-outcomes.pdf] site visited on 12 August 2017.

Druilhe, Z. and Barreiro-Hurlé, J. (2012). Fertilizer Subsidies in Sub-Saharan Africa. Agricultural Development Economics Division Food and Agriculture Organization of the United Nations. [www.fao.org/economic/esa] site visited on 13 May, 2017.

Eboh, E. C., Ujah, O. C. and Amaechina, E. C. (2006). Does Government Fertilizer Subsidies Benefit Rural Poor Farmers in Nigeria? Making Sense out of Existing Data. *PMMA Network Session Paper.* Available online at: [http://132.203, 59] site visited on 13 May, 2017.

Ellis, F. (1992). Agricultural Policies in Developing Countries. *American journal of Agricultural Economics* 75(2): 45-67.

Enemchukwu, D. C., Ugwumba, C. O. A. and Okeke, U. (2017). Performance of the Growth Enhancement Support Scheme (G.E.S.S.) Among Food Crop Farmers in Anambra State, Nigeria: *International Journal of Multidisciplinary Research and Analysis* 1(1): 13–22.

Fisher, M. and Kandiwa, V. (2014). Can Agricultural Input Subsidies Reduce the Gender Gap in Modern Maize Adoption? Evidence from Malawi. *Food Policy* 45: 101–111. https://doi.org/10.1016/j.foodpol.2014.01.007.

FMARD, (2011). Nigerian Agricultural Transformation Agenda: we will grow Nigerian Agricultural Sector. 89pp.

FMARD, (2014). Growth Enhancement Scheme. Federal Ministry of Agriculture and Rural Development, Abuja, Nigeria. Available on the internet [athttp://www. fmard.gov.ng/] site visited on 15 May, 2017.

Gilbert, J. R. (2020). Inorganic Fertiliser Use Among Smallholder Farmers in Sub-Saharan Africa: Implications for Input Subsidy Policies'. In; G. Paloma, S. Riesgo, and L. K. Louhichi (eds), *The Role of Smallholder Farms in Food and Nutrition Security*. Cham: Springer link.

Hemming, D.J., E.W. Chirwa, A. Dorward , H.J. Ruffhead , R. Hill, J. Osborn, L. Langer, L. Harman, H. Asaoka, C. Coffey, and D. Phillips (2018). 'Agricultural Input Subsidies for Improving Productivity, Farm Income, Consumer Welfare and Wider Growth in Low- and Lower-Middle-Income Countries: A Systematic Review'. *Campbell Systematic Review* 14(1): 1–153. https://doi.org/10.4073/ csr.2018.4

Holden, S. T and Lunduka, R. W. (2013). Who benefit from Malawi's targeted farm input subsidy program? In: *Forum for Development Studies* 40(1): 1-25).

Holden, S. and Lunduka, R. (2012). Do fertilizer subsidies crowd out organic manures? The case of Malawi. *Agricultural Economics* 43(3): 303-314.

Ibrahim, H. Y. I., Ale-ojo, H. A. I. and Wahab, M. J. (2018). Impact of the Growth Enhancement Support Scheme (GESS) on Maize Farmers in Dutsinma Local Government Area of Katsina State, Nigeria FUDMA. *Journal of Sciences* (*FJS*) 2: 143-148.

Ikejiofor, U. (1998). Access to Land, Development Control and Low-income Housing in Abuja, Nigeria: Policy, Politics, and Bureaucracy: *Planning, Practice and Research* 13(3): 299-309.

Isinika, A., Mlay, G., Boniface, G., Mdoe, N., Poulton, C. and Saha, A. (2020). *Does Rice Commercialization Impact on Livelihood? Experience from Mngeta in Kilombero District, Tanzania,* APRA Working Paper 30, Brighton: Future Agricultures.

Jayne, T. S. and Rashid, S. (2013). Input Subsidy Programs in Sub-Saharan Africa: A Synthesis of Recent Evidence'. *Agricultural Economics* 44(6): 547–62. https://doi.org/10.1111/agec.12073.

Jayne, T. S., Mason, N. T., Burke, W. J. and Ariga, J. (2018). 'Review: Taking Stock of Africa's Second-generation Agricultural Input Subsidy programs'. *Food Policy* 75: 1–14. https://doi.org/10.1016/j.foodpol.2018.01.003.

Jayne, T. S., Mather, D., Mason, N. and Ricker-Gilbert, J. (2013). How do fertilizer subsidy programs affect total fertilizer use in sub-Saharan Africa? Crowding out, diversion, and benefit/cost assessments. *Agricultural Economics* 44(6): 687-703.

Kato, T. (2016). *Agricultural Input Subsidies in Sub-Saharan Africa – The Case of Tanzania.* Doctoral thesis (PhD). Brighton: University of Sussex. Available at: [http://sro.sussex.ac.uk/id/eprint/64928] site visited on 22 October, 2020.

Kinuthia, B. K. (2020). Agricultural input subsidy and farmers outcomes in Tanzania. WIDERWorkingPaper2020/149.Helsinki:https://doi.org/10.35188/UNU-DER/2020/9068.

LaFave, D. and D. Thomas (2016). 'Farms, Families, and Markets: New Evidence on Completeness of Markets in Agricultural Settings'. *Econometrica* 84(5): 1917–1960. https://doi.org/10.3982/ECTA12987.

Liverpool-Tasie, L. S. O. (2013). Do Vouchers Improve Government Fertilizer Distribution? Evidence from Nigeria: *Agricultural Economics* 2013: 12-33. DOI: 10.1111/ agec.12094.

Liverpool-Tasie, L. S. O. and Takeshima, H. (2013). Input Promotion within a Complex Subsector: Fertilizer in Nigeria. *Agricultural Economics* 44(6): 581-594.

Lunduka, R., Ricker-Gilbert, J. and Fisher, M. (2013). What Are the Farm Level Impacts of Malawi's Farm Input Subsidy Program? A Critical Review'. *Agricultural Economics* 44(6): 563–79. https://doi.org/10.1111/agec.12074.

Mason, N. M. and Ricker-Gilbert, J. (2013). Disrupting demand for commercial seed: Input subsidies in Malawi and Zambia. *World Development* 45: 75-91.

Mason, N. M. and Smale, M. (2013). Impacts of Subsidized Hybrid Seed on Indicators of Economic Well-being among Smallholder Maize Growers in Zambia: *Agricultural Economics* 44(6): 659-670.

Mason, N. M., Jayne, T. S and Mofya-Mukuka, R. (2013). Zambia's input subsidy programs. *Agricultural Economics* 44(6): 613-628.

Michael, A., Tashikalma, A. K. and Maurice, D. C. (2018). Agricultural inputs subsidy in Nigeria: An overview of the growth enhancement support scheme (GESS). *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis* 66(3): 781-789.

Mohammed, A. I. (2017). *Farm Credit, Farmland, Farm Infrastructure and Agricultural output in Kano State, Nigeria: the moderating effect of Murabahah finance*. Doctoral Dissertation for Award Degree of PhD. at University Utara Malaysia. 142pp.

Morris, M., Valerie, A., Kelly, R., Kopicki, J. and Byerlee, D. (2007). Fertilizer Use in African Agriculture, Lessons Learned and Good Practice Guidelines.

Directions in Development Agriculture and Rural Development 39037, The International Bank for Reconstruction and Development / The World Bank. 120pp.

Mortimore, M. (1993). Northern Nigeria: Land Transformation Under Agricultural Intensification. In; *Population `and land use in developing countries: report of a workshop*. pp. 42-69.

Motilewa, B. D., Worlu, R. E., Adepoju, Y. and Fayomi, O. O. (2015).Interogating the citizen-centred services and Development in Nigerian Agricultural sector through E-governance in Nigeria. Paper presented at Covenant University conference on E-governance in Nigeria, 3 -5 September, 2015.

Nagy, J. G. and Edun, O. (2002). Assessment of the Nigerian government of Policy and suggested alternative market-friendly policies. Muscle Shoals, AL, USA: International Fertilizer Development Center. 40pp.

Nantakyi-Frimpong, H. (2017). Agricultural diversification and dietary diversity: A feminist political ecology of the everyday experiences of landless and smallholder households in northern Ghana. *Geoforum* 86: 63-75.

National Population commission (2006). 2006 Census results Retrieved on from [http;// www.npc.gov.ng] site visited on 24th October, 2017.

NBSN (2010). Nigeria poverty profile [availableonlinet:http://www.nigerianstat. gov.ng/pdfuploads/Nigeria%20Poverty%20Profile%202010.pdf.NPC] site visited on 14 May, 2017.

Nimako, S. A. (2019). *Analysis of the Effects of Fertilizer Subsidies on Crop Diversification and Income and Their Implications for Diet Quality in the Upper West Region of Ghana*. Doctoral Dissertation for Degree Award at University of Nairobi. 124pp.

Nwalieji, H. U., Chukwuemeka, O. O. and Uzuegbunam, C. O. (2015). An Assessment of Growth Enhancement Support Scheme among Rice Farmers in Anambra State, Nigeria: *Journal of Agricultural Extension* 19(2): 71-81.

Ogunniyi, A., Oluseyi, O. K., Adeyemi, O., Kabir, S. K. and Philips, F. (2017). Scaling up agricultural innovation for inclusive livelihood and productivity outcomes in sub-Saharan Africa: The case of Nigeria. *African Development Review* 29: 121-134.

Ogunniyi, A., Omonona, B., Abioye, O. and Olagunju, K. (2018). Impact of irrigation technology use on crop yield, crop income and household food security in Nigeria: A treatment effect approach. *AIMS Agriculture and Food* 3: 154–171

Olagunju, K. O., Ogunniyi, A. I., Awotide, B. A., Adenuga, A. H. and Ashagidigbi, W. M. (2019). Evaluating the distributional impacts of drought-tolerant maize varieties on productivity and welfare outcomes: an instrumental variable quantile treatment effects approach. *Climate and Development* 2019: 1-11.

Olomola, A. S. (2015). Understanding the framework for intergovernmental interactions in the implementation of Nigeria's Agricultural Transformation Agenda. *Nigeria Strategy Support Program II, Working Paper*. 27pp.

Omotayo, A. O., Adenegan, K. O., Bola, A. A. and Ogunniyi, A. I. (2017). The Growth Enhancement Support Scheme: Productivity and Shortcomings among Rice Farmers in Ekiti State, Nigeria. *Acta Universitatis Danubius. Œconomica.*

Oyediran, W. O., Dick, T. T., Owolade, E. O. and Oluade, E. A. (2015). Contributions of Growth Enhancement Support Scheme (GESS) programme to food security and poverty alleviation of Agricultural Cooperatives in Ogun State, Nigeria: *Journal of Educational Policy and Entrepreneurial Research* 2(6): 13-22.

Ricker-Gilbert, J., Jayne, T. S. and Chirwa, E. (2011). Subsidies and Crowding out: A Double-hurdle model of Fertilizer Demand in Malawi. *American Journal of Agricultural Economics* 93(1): 26-42.

Ricker-Gilbert, J., Mason, N. M., Darko, F. A. and Tembo, S. T. (2013). What are the effects of input subsidy programs on maize prices? Evidence from Malawi and Zambia. *Agricultural Economics* 44(6): 671-686.

Sadoulet, E. and de Janvry, A. (1995). *Quantitative Development Policy Analysis*. Baltimore and London: The John Hopkins University Press. 78pp.

Shively, G. E. and Ricker-Gilbert, J. (2013). Measuring the Impacts of Agricultural Input Subsidies in Sub-Saharan Africa: Evidence from Malawi's Farm Input Subsidy Program," *Global Policy Research Institute (GPRI) Policy Briefs*: Vol. 1: Iss. 1, Article 4. Available at http://docs.lib.purdue.edu/gpripb/vol1/iss1/4

Simon, M. K. and Goes, J. (2013). Assumptions, limitations, delimitations, and scope of the study. [www.dissertationrecipes.com] site visited on 23 September 2019.

Singh, I., Squire, L. and Strauss, J. (Eds) (1986). *Agricultural Household Models: Extensions, Application, and Policy*. Hopkins University Press. London. 325pp.

Song, S. and Imai, K. S. (2019). Does the Hunger Safety Net Programme reduce Multidimensional poverty? Evidence from Kenya: *Development Studies Research* 6(1): 47-61. DOI: 10.1080/21665095.2019.158234.

UNDP (2016). Nigerian Human Development Report Working Paper No. 12-04. FAO, Italy, Rome.

UNDP (2019). *Human Development Report. Table 6: Multidimensional Poverty Index: Developing Countries*, New York: United Nations Development Programme, [http://hdr.undp.org/en/content/table-6-multidimensional-poverty-index-Developing-countries] site visited on 5 September 2019.

World Bank (2019). *Tanzania Economic Update: Transforming Agriculture*. Washington, DC: World Bank. 78pp.

Wossen, T., Abdoulaye, T., Alene, A., Feleke, S., Ricker-Gilbert, J., Manyong, V. and Awotide, B. A. (2017). Productivity and welfare effects of Nigeria's e-voucher-based input subsidy program. *World Development* 97: 251–265.

CHAPTER TWO

2.0 Impact of Growth Enhancement Support Scheme on Productivity of Smallholder Maize Farmers in Kano state, Nigeria

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Abstract

In a consistent effort to raise productivity and unlock the unrivaled economic potential of the agricultural sector, the Nigerian government implemented the Growth Enhancement Support Scheme 2011. The aim of GESS was to raise farmers' productivity by subsidizing key agricultural inputs. This paper provides an empirical insight into the impact of GESS subsidy on maize productivity of smallholder farmers in Kano state with a view to providing policy recommendations for enhancing programme effectiveness. A two-stage random sampling with stratification was employed to select villages and households from in the state. The representative sample comprised of 170 GESS participants and 220 non-participants. As an analytical approach, the study employed Propensity Score Matching (PSM) and Instrumental Variable (IV) method to adjust for sample selection bias and potential endogeneity associated with non-random assignment of treatment. The PSM and IV results showed that GESS increase maize yield of participating households by 25% and

37.7% respectively. Overall the findings suggest that GESS programme is effective in improving the maize yield of smallholder farmers in the study area. Other factors that were found to contribute positively to maize productivity are land size, membership to commodity associations, years of education, household size and age of household head. The distance to village market showed negative relationship with productivity. The study recommended that the government should support and promote community institutions and increase expenditure on road infrastructure.

Key words: GESS subsidy, Maize productivity, Kano and smallholder farmers.

2.1 Background to the Study

In order to promote the use of productivity enhancing technology such as fertilizers and improved seeds, many countries in SSA implemented universal input subsidy programmes in the 1970s and 1980s (Jayne *et al.*, 2013; Hemming *et al*., 2018). For example universal subsidy programmes were implemented in Malawi, Tanzania, Ghana, Kenya, Zambia, Nigeria, Zimbabwe and Mozambique spanning from 5 to 10 years (Liverpool-Tasie, 2013; Shilvey and Ricker-Gilbert, 2013). The implementation of farm subsidies was seen as a step towards achieving developmental goals such as food security, trade promotion, and poverty reduction in the continent and SSA in particular (Jayne et al. 2018). These subsidies supported state policies by providing direct support to farmers and were seen as a key tool for rural transformation through agricultural intensification (Kato, 2016). However, they represented a huge financial burden and became fiscally unsustainable (Chirwa and Dorward, 2013; Jayne and Rashid, 2013). In particular, Nigeria implemented different universal input subsidy programmes under different administration. However, all the subsidy programmes were widely criticized as being associated with multiple problems, including; large scale corruption, inefficiency in subsidy administration and

implementation (Akande *et al*., 2011) hence subsidy programmes lack any basis, application, impact and sustainability (IDEP,2011) (International department for the eradication of poverty). Although a positive growth rate of agricultural gross domestic product (GDP) per capita was reported in some countries, food crop yields stagnated in the region (World Bank, 2007). Moreover, the contribution of farm input subsidy programme in Nigeria remained low with no impact on food security and poverty reduction (Nagy and Edun, 2002; Fan *et al.*, 2008). Due to the fiscal unsustainability and inefficiency of these state-controlled policies, structural adjustment programmes were introduced in the agricultural sector in the 1980s and 1990s. The implementation of Structural Adjustment Programme (SAP) led to the scrapping of universal FISP across SSA with the premise that the private sector can provide farm inputs more efficiently through market mechanisms (Ricker-Gilbert, 2014). The consequence of the market liberalization was low adoption of modern farm inputs (Winter – Nelson and Temu, 2005). It appears that even before market liberalization, fertilizer use was still low in SSA and it got worse with the market liberalization. In the case of Nigeria, fertilizer use dropped from 13kg/ha to 8kg/ha, far below SSA average of 21kg/ha and world average of 100kg/ha (Banful, 2010; Amani *et al.*, 2010) examined the effect of market liberalization programme on crop productivity and found that the liberalization period led to a decrease in maize yield and other cereals from 1800kg/ha to 1000kg/ha on average.

In 2011, the Nigerian government implemented the Growth Enhancement Support Scheme (GESS) with the intention of reversing the declining trend in fertilizer use and crop productivity. The broad objective of the scheme was to remove the complexities associated with past subsidy programmes and to encourage critical actors in the fertilizer and seeds value chain to work together to improve productivity, food security and

promote the development of input markets (FMARD, 2012; Motilewa, 2015). The rationale for the engagement of private sector was to limit government's involvement in the procurement and distribution of farm inputs and to stimulate demand for commercial input (Liverpool-Tasie and Takeshima, 2013; Ibrahim *et al*., 2018). According to Fadairo *et al*. (2015), GESS participation was based on some attributes; a beneficiary should be 18 years and above, and should possess and own a mobile phone, and hold not more than 3 hectares of land and in addition should also be a resident in the village for not less than 10 years. A participant should also be identified by the village head and his or her bio data is captured in the data base of GESS which contains an e-wallet that hosts beneficiary's' phone numbers. The number entitles the registered farmer to 2 bags of 50kg fertilizer (NPK and Urea) and a 25kg of improved maize seeds (Wossen *et al*., 2017).

Some studies have examined the impact of GESS subsidy programme on maize productivity in different parts of Nigeria. For example, (Alabi and Adams, 2020) used household survey data to estimate the impact of E-wallet fertilizer scheme and its implication on food security in Nigeria, the authors found that GESS increased average maize yield of participating households by 66%. In another study, Oguniyi and Kehinde (2015) used household survey data to examine the Impact of GESS subsidy on improved livelihood and productivity outcomes of smallholder crop farmers in rural Nigeria, they also found that GESS subsidy increased maize yield of participants by 16.8 %. While Wossen *et al*. (2017) using a nationally representative household survey data also examined the impact of GESS subsidy on maize productivity of smallholder farmers in Nigeria and found that GESS substantially increase maize yield of participating households by 26.3%. In another, Oguniyi *et al*. (2017) examined the impact of inclusive livelihood and productivity outcomes in SSA using Nigerian GESS as a case and also

found that GESS significantly increased the value of output by 54.4 %. Although all these studies based on non-randomized design and also applied analytical methods to control for selectivity and potential endogeneity, we observed that while the direction of the findings are similar, quantitative effects vary, suggesting that programme effect may be location specific. According to (Eva, 2018), subsidy programmes can only succeed in improving farmers' outcomes if location specific constraints are addressed (Eva, 2018). To the best our knowledge no study has evaluated the impact of GESS subsidy on productivity of smallholder maize farmers in Kano state. Therefore, with many farmers growing maize in Kano, even small changes in maize productivity is likely to impact the life of poor and food insecure households.

This paper contributes to the body of knowledge on farm input subsidies. This study therefore focuses on the question; what was the impact of GESS subsidies on maize farmers' productivity? and what factors influence maize productivity in Kano State? From a policy perspective, the answers to these questions are important in addressing the dwindling agricultural productivity of smallholder farmers in achieving household food security and poverty reduction.

The rest of the paper is organized as follows: The next section presents research methodology then results and discussion. The final section concludes with summary and recommendations from the findings of the study.

2.2 Research Methodology

2.2.1 Description of the study area

The study was conducted in Kano State, Northwest, Nigeria in 2017. Kano state is also located in the North-west Geopolitical Zone of Nigeria between latitudes 130^0 N and 110^0 S and longitudes 80^0N and 100^0 E with a landmass of 20 760 km^2. It's the largest state in Nigeria with 44 local governments. The state has a projected population of 11 206 688 million in 2012 based on 2006 national population census (NBSN, 2010). The average annual rainfall is 700 mm with 35^0 C and 19^0 C as mean daily maximum and minimum temperatures respectively. The Major food crops cultivated by farmers in the state include maize, rice, millet, cowpea, groundnut, fruits and vegetables which are grown as mixed cropping or in rotations. The holding size ranges from 1 to 10 hectares with a mean size of about 2 ha and estimated annual cereal production is between 1200 kg/ha to 1800 kg/ha in 2015 (Mohammed, 2017).

2.2.2 Sampling procedure and data collection

The study employed a two-stage sampling design with stratification to draw a representative sample of GESS participants and non-GESS participants. In the first stage 30 villages were randomly selected from 10 local governments were GESS was implemented in the state in order to capture subsidy information. The list of the villages under GESS programme was obtained from Kano Agricultural and Rural Development Agency (KNARDA). In the second stage a list of participants and non-participants collected at the village extension office was used to draw a sample size of 390. A total of 390 farmers; 170 GESS participants and 220 non-participants were involved in the cross-sectional survey. However, our inability to maintain the same population size for each stratum in the second stage suggest that sampling size may not be based on probability

proportional to size, hence we acknowledge difficulties in selecting a truly representative sample (table 1.1). The study classified a household as GESS participants if it received subsidized inputs (i.e. if the household received subsidy denoted by two bags of 50 kg fertilizer and 25 kg improved maize seeds). A survey questionnaire was designed to capture detail information on socio-economic characteristics of the household, crop production, input used, household productive assets, and information on GESS participation was also collected. In addition, village-level data was collected on prices of key inputs and crops.

2.3 Analytical Techniques

2.3.1 Measurement of maize productivity

Empirical studies on the impact of farm subsidy on productivity of smallholder farmers have applied different productivity metrics. Common metrics of agricultural productivity are based on the relationship between output and conventional inputs such as land, labour and capital. These are partial and total factor productivity measures which are used to assess input use efficiency. For example, while (Liverpool-Tasie, 2013) used partial factor productivity measure to evaluate the impact of farm subsidy on maize production in Malawi and Zambia, Ibrahim *et al*. (2018) used total factor productivity index to measure the impact of GESS subsidy on maize productivity maize in Katsina state. Similarly, Aloyce *et al*. (2014) used aggregate partial productivity to assess the impact NAIVS on crop productivity in Tanzania. Fertilizers, high yielding seeds and pesticides are complementary inputs which are determinants of productivity (Kamara, 2004). Similarly, Aloyce *et al*. (2014) used aggregate partial productivity to assess the impact NAIVS on crop productivity in Tanzania. In this study we used maize yield per hectare of land cultivated as a measure of productivity. Land productivity i.e. output per unit of land used is more useful for policy makers interested in agricultural policy or land management.

First, this approach allows us to understand the efficiency of land that is of interest in the context of GESS subsidy which seeks to improve land quality in order to enhance crop yield. Secondly, it reveals the efficiency of the other inputs used since the objective of GESS is to increase the use of productivity enhancing inputs. Yield is an important indicator of land productivity and also provides a basis for assessing whether the environment is supporting the livelihoods of the households who farm the land. Thirdly, land is a major limiting factor in agricultural production, an increase in land productivity is a key factor in any agricultural development agenda (Amare *et al*., 2018). Some impact assessment studies such as (Oguniyi and Kehinde, 2015; Oguniyi *et al.*, 2017; Wossen *et al*., 2017; Abdoulaye *et al*., 2018; Wossen *et al*., 2018) have used yield per hectare to measure land productivity. GESS programme may have potential effect on other crops because participating farmers were not required to use the subsidized inputs on a particular crop, The study choose to consider maize yield as a productivity outcome because maize is the most important food crop in Nigeria , more so governments objective is to promote the production of maize in Northern, Nigeria. In addition, maize also stands to benefit more from fertilizer subsidies as response rate of improved maize is higher than other crops.

GESS subsidy distributed subsidized fertilizers and seeds to boost maize productivity; we expect that GESS will contribute to increasing maize productivity. Most farmers are net consumers of own production ,increase in maize production may indicate an improvement in household food security so long as increasing maize productivity is not off- set by decrease in the production of other staple crops. The study focus on smallholder maize farmers who grow other crops. We observed both farm and nonfarm activity of the farmers to understand programme impact.

2.3.2 Estimation method

GESS subsidy was not distributed randomly across villages and farmers', identifying the causal effects of GESS subsidies requires controlling for selectivity and endogeneity problems arising from observable and unobservable factors respectively. This paper employed Propensity score matching (PSM) and IV- regression approach to address such unexpected behavior among variables.

2.3.2.1 Estimation of treatment effect of GESS on maize productivity using PSM method

Establishing the causal effect of GESS participation on maize yield of participants would require creating a counterfactual group. A counterfactual group is similar in characteristics to the treatment group but without receiving treatment (Rosenbaum and Rubin, 1983).Farmers that were selected into GESS and non-GESS groups are assumed to have potential outcome $Y_{i1,} \wedge Y_{0i}$ where $Y_{i1,}$ is maize yield if ith farmer were involved in GESS programme $, Y_{0i}$ is maize yield if ith farmer was not involved in the GESS programme. Let Z be an indicator variable in the interval {0 1} showing the actual status of the ith farmer with regard to GESS. The actual yield of ith farmer is given by equation 1

$$Y_{i1,} = Y_{0i} + \text{Zi} \quad (\quad Y_{i1,} - Y_{0i} \quad)$$

……..... (1)

Therefore, the effect of GESS participation on maize for the ith farmer would be Y ¿ ¿ ¿) is not possible to observe since a farmer cannot be in two states simultaneously. Therefore, the potential difference in maize yield is captured only by observable characteristics (X) and is independent of the participation status. We constructed the counterfactual E(Y_0 | Z=1).The counterfactual shows the maize yield that GESS participants would have lost on average had they not participated in the programme.

We first estimated the propensity scores. The propensity score is defined as the conditional probability of being a GESS participant given pre-treatment characteristic. The propensity scores were computed using binary logistic regression model and is given by equation 2

$P(X)=P[Z=1/X] = [Z/X;F(h/X_i)]$ ………………………………………………… (2)

F (.) is a logistic cumulative distribution function, $Z(0,1)$ represents farmers' participation status which takes of 1 if a farmer is GESS participants and 0 if otherwise is a multidimensional vector of observed variables characterizing maize farmers which can hinder or promote farmers participation in the context of rural Nigeria. We include a set of variables that captures household socio-economic characteristics of the farmers such as age, gender, household size, years of schooling, sex. We also account for institutional variables which includes farmers access to credits, number of extension visits per month as well as capture households wealth status such as area cultivated, total household land holding .Village level characteristics such as distance to redemption centre, distance to market that are likely to influence farmers participation decision were also included in the PS model. The explanatory variables considered in this study were based on economic theory and review of previous empirical literatures on impact evaluation and productivity in SSA (Ogunniyi and Kehinde, 2015; Oguniyi *et al.*, 2017). The rationale for including these variables in the PS model was based on the assumption that the variables are those which jointly predict GESS participation and maize productivity. According to Caliendo and Kopeinig (2008), the conditioning variables used to construct the propensity scores should be related to programme participation and outcomes (Heckman *et al.*, 1999). For

instance, age of the household head is a proxy for farming experience; it can have a positive influence on GESS participation. Years of education which is measured by level of education also captures the level of farming skills needed to take advantage of modern technology in form of inorganic fertilizer and improved seeds. Some impact evaluation studies have found positive impact of education on programme participation (Kassie *et al.*, 2012; Oguniyi *et al*., 2018). Membership of commodity association measures the level of social capital or network of farmers. Farmers tend to take advantage of membership in sharing labour, securing credits and insurance against risk Wossen *et al.* (2015). However the effect of some of the variables cannot be determined apriori. Table 2.1 provides the full list of variables used in the estimation of PS model and outcome equation.

Table 2.1: Definition of the variables used in the models

Variable	**Type and definition**	**Measurement**	**Expected sign**
Dependent variable	Continuous ; maize yield	Kg/hectare	
Independent variables			
Institutional variables			
GESS subsidy	Dummy; Treatment variable	Instrumented	+
Num_ext	Number of extension visit	Number of extension visits per month	+
Acc_credit	Dummy Household access to credit	1 if household access credit during the farming season under consideration ,0 otherwise	+/-
Socio-economic characteristics			
Sex_HH	Dummy,sex of household head	I if male,0 otherwise	+/-
Age_HH	Continuous ,age of household head	Full years of household head	+/-
H Hsize	continuous, household size	Number of all household members in the house	+
Yrsedu_HH	Continuous ,number of years of education of household head	Number of years of formal schooling	+
Household characteristics			
Area_maize	Area under maize cultivation	Total area in hectares	+
Mem_comm	Dummy, household membership of commodity association	1 if household is a member of maize farmers' association	+
	Dummy :phone ownership	1If household head own a	+

		mobile phone	
Village level characteristics			
Dis_mkt	Distance to market	in kilometers	-_

After estimating the propensity scores, we employed nearest neighbor, caliper and Kernel matching methods to achieve covariate balance and common support condition. The closer the propensity scores of the treatment and control group the better the match for the control (Priscilla *et al*., 2012). We then check the quality of a given matching technique by (i) standard mean bias (Rosenbaum and Rubin,1985) (ii) a t-test (Rosenbaum and Rubin,1985), joint significance of variables and pseudo R^2 (Sianesi, 2004) before and after matching. We employed nearest neighbor, caliper and Kernel matching methods. In the next step, we perform balancing property test (t-test) to check statistically of the variables before and after matching (Caliendo and Kopeinig, 2008). The covariate balance was checked to satisfy the common support condition; this condition requires $0<P(Z=1|X=x)<1$ for all x contained in X. We estimated ATT after achieving the common support condition. The ATT is given by equation 3.

ATT= E($Y_{i1,}-Y_{0i}$ |Z=1)=E(Y_1 |Z=1)-E(Y_0 |Z=1) ……. ……(3)

2.3.2.2 Estimation of treatment effect of GESS subsidy using IV-2SLS

PSM only adjusts for selection bias resulting from observable factors. Some observable and unobservable factors that may affect treatment may also affect productivity. However, to estimate ATT requires controlling for both observable and unobservable factors that influence both GESS participation and maize yield. Hence, the estimates of eq (3) may give biased and inconsistent estimates of maize yield due to potential endogeneity arising from unobservable factors. The potential sources of endogeneity in the case of GESS programme could arise from farmer's intrinsic characteristics such as better farming skills

and management abilities, wealthy, educated, or more productive farmers are more likely to choose to participate This requires another variable which correlates with GESS participation but uncorrelated with maize yield only through farmers decision to participate in the programme. This variable is an instrumental variable, instrumental variable controls for unsuspected behavior among variables in a model. The study applied the instrumental variable method to obtain consistent and unbiased estimate of ATT.

Based on studies such as (Ricker-Gilbert *et al*., 2011; Shively *et al*., 2012; Chirwa and Dorward, 2013; Mason and Ricker-Gilbert, 2013; Shivey and Ricker–Gilbert, 2013; Wossen *et al*., 2017), we identified two variables that have no direct effect on productivity except through their effect on GESS participation. The variables are the number of years of residence of the household head in the village and membership of the ruling political party. Years of residence in the village can influence registration into GESS subsidy without influencing maize productivity (Aloyce *et al*., 2014). A farmer's membership of the ruling political increases his chances of being registered into GESS programme. Farmers develop networks of relationships among themselves which can facilitate their decision to participate in such programmes without affecting their farm productivity directly. The farmer may exercise more political influence than a non-member of the ruling political party. Moreover, we check the validity of the instruments (Appendix 2.4) and the results suggest no causal effect of the variables on maize productivity providing evidence that the instruments are valid. Moreover, we performed Wu-Haussmann – F-test and Durbin-Wu-Haussmann –chi-square 'ivendog' command to test treatment endogeneity. In addition, Jansen-Hargan test of over-identification was performing to verify the exogeneity of the instrument.

The first stage of the 2SLS we predicts GESS participation which is given by equation 4

$G_i = \gamma Z_i + \beta X_i + \varepsilon_i$ ……..…….... (4)

Where G_i is GESS participation captured as a dummy variable indicating whether a Household was a participant or not, Z_i are instruments (farmers years of residence in the village and membership of ruling political party) representing GESS participation, $X_i \, is \, a \, vector$ that represents exogenous factors hypothized to influence GESS participation, $\gamma \wedge ¿ \quad \beta$ are unknown parameters to be estimated while ε_i is error term of the treatment model.

The first stage equation (Eq4) is a [2]linear probability model which predicts the outcome variable (G_i). we used the LPM because we are interested in the marginal effect of changing Z_i and predicted values of (G_i) . We entered the predicted values of (G_i) in the second stage as an independent variable to replace G_i .

In the second stage, we specify a log-linear functional form for maize yield to estimate the impact of GESS subsidy on maize productivity. The model is given as

ln $Y_i = \sigma \hat{G}_i + \delta X_i + \beta w_i + ¿ \quad \mu_i$

…… (5)

Where ln Y_i is log of maize yield (kg/ha) of i[th] farmer, the natural log is used for linear transformation of maize yield , $\hat{G}_i$ is the predicted values of GESS participation from first step, X_i is a vector of institutional and social capital factors (access to credit ,number of extension visit ,membership of commodity association hypothesized to influence maize productivity, w_i is a vector of farm and farmer ,village and household

2 A linear probability models uses OLS estimator to predict a binary dependent variable.

asset characteristics (such age, sex, household size, years of schooling ,area cultivated ,total landholding and distance to market influencing maize productivity and factor efficiency, δ, β are unknown parameters to be estimated the impact of GESS on maize productivity, μ_i is the error term. While σ is the parameter we seek to estimate in equation (5); that is, how does maize yield change given a change in subsidized inputs acquired by the household through GESS participation, holding other factors constant. The variable G in equation 5 is a quasi-fixed factor which represents subsidized inputs received by the farmer. Hence the inputs are implied in G. This justifies the exclusion of the input variables in the productivity model (equation 5). Table 2.1 provides the definition of the variables used in the estimation of the outcome model.

2.4 Results and Discussion

2.4.1 Descriptive statistics of socio-demographic characteristics of the respondents

Measures of central tendency and dispersion including arithmetic mean were used to differentiate maize farmers with respect to their socio-demographic characteristics. We present the descriptive statistics of all the variables of interest in Tables 2.2 and 2.3. In Table 2.2, we present the statistics of quantitative variables while in Table 2.3 we present the test of association between some qualitative variables and GESS participation status. The statistics of the quantitative variables in table 2.2 reveal that on average, the maize yield was 2653 kg/ha. However, the average maize yield of GESS participants (2119kg/ha) was significant higher than that of non-participants (1890 kg/ha) at $p \leq 0.01$. The findings also indicates that the average years of schooling of the household head in the full sample is 13 years while the difference in years of schooling between GESS participants and non-participants was statistically significant indicating

that GESS subsidy reach more literate farmers. This is not surprising because education is an important factor in changing attitudes and motivation of the farmers.

In addition, the results further show that the average age of the household head in the sampled population is 47 years and there was no significant difference in age between GESS participants' non-participants, indicating that GESS registered more elderly people. Most young people migrate out of their villages in search for economic opportunities outside agriculture while others migrate for educational purpose. This finding is a reflection of Nigerian's population structure where majority of the farmers are in their productive age and require more support in terms of production inputs. Age of the decision-maker is an important factor influencing training, knowledge and extension for people of this age.

Furthermore, on average, the landholding size of the sampled household was 4.4 hectare and GESS participants do not differ from non-participants in average landholding size. This suggests that land, which is the most important productive assets in crop production, is not a constraint among farmers in the study area. Although farmers vary significantly with respect to area cultivated due to variation in household resource endowment, GESS was design to target famers with 3hectares and below, therefore the finding may suggest that some unintended beneficiaries were registered into the programme implying that the eligibility criteria for programme participation was not fully adhered to .Similar findings have been reported by (Houssou *et al*., 2017; Mason and Ricker-Gilbert, 2013; Wang *et al*., 2019; Kinuthia, 2020). Jayne and Rashid, (2013) reviewed the implementation of farm input subsidies in SSA and found that in general, households with larger landholding captured more fertilizer subsidies even though subsidies were targeted at poorer farmers. This also indicates that the eligibility criterion was not adhered to. Similar findings have

also been reported by (Houssou *et al*., 2017; Mason and Ricker-Gilbert, 2013) in Ghana, Malawi and Zambia respectively

Fertilizer constitutes the largest share of GESS subsidy value and remains the primary input that is sourced using the GESS e-voucher input support. The results in table 2.2 also show a significant difference in fertilizer used between both groups. The average fertilizer used for GESS participants was 38kg/ha compared to 32 kg/ha for non-participants although the average fertilizer is still below governments target of increasing fertilizer used from 13 kg/ha to 50 kg/ha. These suggest that GESS subsidy encouraged farmers to purchase more fertilizer from private input market. In a study by (Uduji *et al*., 2019) who effect the effect of GESS on fertilizer used in Nigeria, found that GESS programme increased farmers access and fertilizer used in Nigeria, moreover, (Liverpool-Tasie *et al*., 2017) found that in Northern Nigeria, average fertilizer use for maize rose to an average of 211 kg/ha. This indicates those GESS subsidies provided a cost relief to the farmers and seem to have positive impact on input market participation, this calls for further study on the impact of GESS on fertilizer market in the study area.

The average household size of the sampled population is 12 members and the mean difference test shows no significant difference in household size between the two groups. As a further indication of the high-scale farming activity in the area, the labor force consisted of not more than ten workers in the surveyed farm households. We also found significant difference between the two groups in terms of the number of years of residence of the household in the village. Table 2.2 indicates a statistically significant difference in number of years of residence between GESS participants and non-participants.

Table 2.3 is a cross tabulation between GESS participation and some socio demographic and institutional factors .We found statistically significant association between marital status and GESS participation. GESS participants differs (94.5%) from non-participants 89.4% with respect to marital status. Moreover the frequency of GESS participation increases with gender, 82% of GESS participants were male and the differ significantly $(P \leq 0.05)$ from non-participants. There are more male participants than female participants. This is not surprising because women often lack capacity (mobility and funds), self-confidence, and more limited in productive assets and economic opportunities, moreover, gender and cultural discrimination may also be a serious constraints to women participation in GESS programme. We also found significant association between membership commodity (73.5%) and GESS participation. The frequency of GESS participants (73.5%) who are members of maize association varies significant from non-participants. Membership of commodity association is a form of social capital which measures farmers' relationships and network. Awareness and knowledge about GESS is created through farmer's association thereby increasing their participation in the programme. Moreover, farmers tend to take advantage of membership in sharing of labour, securing of credit and insurance against risk (Wossen *et al*., 2015).

GESS participants also differs from non-participants by membership of ruling political party,79.4% of GESS participants were registered members of the ruling political party; Peoples Democratic Party (PDP) compared to 82.7% of non-participants who were not registered members of the ruling political party. This means that GESS participation may be correlated with political factors. A study by (Liverpool-Tasie and Takeshima, 2015) examined fertilizer subsidies, political influence and local prices in SSA, with evidence from Nigeria, found that fertilizer subsidies were captured by politically influential agents in many communities in Nigeria. This is not surprising because government is always

under pressure to fulfill the political goal against the wish of the people (Banful, 2011). Ayinde *et al*. (2019) reviewed the Politics in fertilizer subsidy implementation and governance structure towards agricultural and economic development in Nigeria and concluded that fertilizer subsidy policy in Nigeria have been changing in volume, structure and approach over time as power changes in the seat of government and is usually marred by unhealthy politics observed among fertilizer policy stakeholders, subsidized fertilizer distribution and marketing as well as in the target and unintended beneficiaries. Moreover, they found that governance structure in Nigeria is poor given that all her governance indicators were negative. In a similar study, (Benin, 2015) found that 82% of Ghana 2008 fertilizer subsidy was targeted to districts aligned with the same party with Government but in contrast with (Banful, 2010) who found out that fertilizer subsidy was distributed to districts were the ruling government lost to their opponents and the similar finding was reported by (Jerven, 2014) in Malawi. Therefore, political considerations are potential threats to the effectiveness and efficiency of FISP subsidy programmes in SSA.

Surprisingly, we did not observe any statistically significant association between GESS participation and phone ownership moreover the difference in phone ownership between the two groups is statistically insignificant. We found that the frequency of GESS participants who are aware of GESS is significantly higher than non-participants. Furthermore, the chi square test of association shows is no statistically significant association between GESS programme. Some socio-economic and institutional factors such as access to credits, land ownership by inheritance, sources of information, keeping of livestock and farming as main occupation were also found to have no association with GESS programme. Overall the result indicates that some institutional, socio economic and demographic factors influenced farmers' participation in GESS programme. This call for

careful investment and policies that will address the features of rural livelihood when designing development programmes.

Table 2.2: Descriptive statistics of the households by participation status

Continuous Variables	Full sample		GESS Participants		Non-participants		Mean.diff	t-value	p-value
	Mean	Std.dev	Mean	Std.dev	Mean	Std.dev			
Maize yield (kg/ha)	2635 kg/ha	1290kg/ha	2590kg/ha	1020kg/ha	2019	1089kg/ha	571kg/ha	3.01	0.00***
Fertilizer used(kg/ha	38.60	4.02	43.30	6.63	33.50	4.58	9.82	3.55	0.00***
Total landholding (ha)	4.23	2.18	4.36	1.26	4.15	2.12	0.22	1.50	0.22
Total area cultivated (ha)	3.64	1.64	3.58	1.64	3.41	1.25	0.17	1.76	0.06*
Age of HH	45.9	9.6	45.8	9.4	45.2	9.7	0.4	0.4	0.7
HH size	12.4	6.9	11.3	4.3	13.0	6.1	3.7	0.6	0.6
Years of schooling	13.2	3.6	13.6	3.5	12.9	3.7	0.7	2.6	0.00**
Years of farming experience	26.8	9.4	26.5	8.9	27.0	9.0	0.5	0.5	0.6
Number of adult family	5.4	3.1	6.0	4.3	7.2	5.4	1.4	1.78	0.06*
Number of extension visits	1.8	1.4	2.2	1.1	2.6	1.5	0.4	2.7	0.01***
Distance to vill. Mkt	4.3	2.1	5.4	3.7	6.1	4.6	0.4	1.2	0.30
Distance to redemption Centre	3.7	1.3	2.6	1.5	3.5	0.9	0.9	7.2	0.00***
Number of years of residence in village	38.6	1.1	40.0	11.6	37.4	9.9	2.9	2.7	0.00***

Note: * Significant 10%, ** significant 5%, *** significant 1%

Table 2.3: Test of association between selected variables and GESS participation

Discrete variables	**GESS –participants N=170**		**Non-participants N=220**		**Chi-square (χ^2)**	**DF**	**sig**
Whether House head is married	N	%	N	%			
Yes	152	89.4	208	94.5	3.559	1	0.059*
No	18	11.6	12	5.5			
Total	170	100	220	100			
Sex					11.557	1	0.003**
Male	153	90	169	76.8			
Female	17	10	51	13.2			
Total	170	100	220	100			
Main activity(farming)					0.6621	1	0.416
Yes	146	85.8	195	88.6			
No	24	14.2	25	11.4			
Total	170	100		100			
Experience shocks(drought and pest)					2.347	1	0.122
Yes	123	72.3	200	90.9			
No	47	27.7	20	9.1			
Total	170	100	220	100			
Market participation					0.3006	1	0.584
Yes	110	64.7	190	86.4			
No	60	35.3	30	13.6			
Total	170	100	220	100			
Maize only					0.066	1	0.967
Yes	69	40.5	45	20.4			
No	101	59.5	175	79.6			
Total	170	100	220	100			
Total	170	100	220	100			
Membership of commodity association					9.889	1	0.034**
Yes	125	73.5	45	20.4			
No	45	26.5	175	79.6			

Total	170	100	220	100			
Member of ruling party					10.123	1	0.044**
Yes	135	79.4	38	17.3			
No	35	20.6	182	82.7			
Total	170	100	220	100			
Household different information sources					0.1668	1	0.689
Yes	165	97.0	181	82.3			
No	5	3	39	17.7			
Total	170	100	220	100			
Phone ownership					0.126	1	0.459
Yes	158	93.0	178	80.9			
No	12	7.0	42	19.1			
Total	170	100	220	100			
Land acquisition(inheritance)					0.0774	1	0.781
Yes	138	81.2	168	76.3			
No	32	19.8	52	23.7			
Total	170	100	220	100			
Access to credit					0.1124	1	0.737
Yes	34	20.0	45	20.4			
No	136	80.0	175	79.5			
Total	170	100	220	100			
Risk a versed(willingness to try new things)					0.0687	1	0.926
Yes	65	38.2	79	35.9			
No	105	67.8	141	64.1			
Total	170	100	220	100			
Keep livestock							
Yes	149	87.6	196	89.0	0.057	1	0.910
No	21	12.4	24	11			
Total	170	100	220	100			

We further examined programme beneficiary selection and implementation process and the result is presented in table 2.4 below. We found that 26.5% of GESS participants admitted to have received more than one e-voucher, this suggest that there were cases of multiple registration contrary to programme design which stipulates one participant to an e-voucher. However, Ibrahim *et al.* (2018) examined the impact of GESS subsidy on productivity of maize farmers in Katsina state, Nigeria and found that some farmers received more than one e-voucher because programme participation allows any household member who is 18 years and above to register. Hence households with large family sizes were more likely to access more subsidized inputs. In another study, (Stein and Lunduka, 2012) analyzed the implementation process of Malawian farm input subsidy and found that errors of inclusion and exclusion resulted in multiple vouchers among beneficiaries. They found that the list of potential beneficiaries was inflated from 2.5 million to 3.8 million resulting in many ghost names to cover up the leakage of subsidized fertilizer into the commercial input market. Similar findings were reported by Banful (2011) who found that the actual regional allocation of vouchers correlated with political factors rather than efficiency or equity consideration in Ghana, Nigeria and Tanzania. (Christiaensen, 2011; Masinjila and Lewis, 2018) found that the implementation of Tanzanian National Agricultural Input Voucher Scheme (NAIVS) was not well implemented because of poor supervision of the vouchers, the involvement of unqualified input dealers, the farmers having limited information about the inputs resulting in cheating and fraud in the distribution of subsidized inputs at the village level. This suggests that subsidy programmes are highly politicized and do not always reach the intended beneficiaries.

We also found that 91% of GESS participants had more than 3 hectares of farm size contrary to programme design which targeted farmers with 3 hectares or less. This suggests that compliance with programme guideline was generally low. Interestingly, we also observed that 85% of the registered farmers received mobile alert but only 75%

redeemed full package of fertilizer and improved maize seed, 15% got partial package (fertilizers or seeds only), while 10% of registered farmers received subsidy without mobile alert. Yusuf and Abdullahi (2015) examined the effectiveness of e-wallet scheme in curbing sharp practices associated with agricultural input accessibility among smallholder farmers in Kano state and found that 32% of beneficiaries who did not registered but did not attend the requisite e –wallet training access the inputs. Suggesting that GESS implementation was characterized by some corrupt and sharp practices in Kano. Studies by (Wossen *et al.*, 2017; Adenegan *et al.*, 2018) also found that 3.7% and 5% of the registered farmers under GESS subsidy managed to collect subsidized fertilizer and improved seeds without receiving a mobile alert in Nigeria and Oyo state respectively . It is likely that the discretionary power of those who identified beneficiaries must have been exploited. The use of village leaders for the identification and registration of participants at the village level may have also compromised the beneficiary selection and implementation process which resulted in the registration of unintended beneficiaries. (Ibitunde *et al*., 2019; Olatohun *et al*., 2019), reported that although farmers express satisfaction with GESS, the implementation was not well effected because of poor supervision of the registration process at the village level.

Druile and Barreiro-Haile (2012) analyzed the implementation of smart subsidy programmes from five countries; Malawi, Nigeria, Zambia and Tanzania and found that although the new generation of input subsidies had some positive impact, they were not free from the problems of the past subsidy programmes. We can infer that the implementation of GESS programme only partly met the expected outcomes in Kano due to mis-targeting, sharp practices of officials, inaccurate identification of beneficiary households, and poor programme implementation. There is the need to improve the design

and implementation of GESS subsidy to realize its full potential, to deliver major benefits to smallholder farmers. This calls for the rethinking and reconceptualization of the design and implementation process of GESS to effectively target the poorest and most marginalized and vulnerable groups in the villages.

Table 2.4: Descriptive statistics of attributes used in Beneficiary targeting

Attributes	Percentage
Household head received more than one voucher	26.5
Participants who registered	100.
Participants who are 18 years and above	100.
Participants whose land holding is more than 3 hectares	91.
Participants who actually own a phone	83
Participants who actually own phone Participants who received mobile alert	85.
Participants who received full subsidy package	75.
Participants who received partial subsidy package	25.
Male participants	82.

2.4.2 Logit results from the estimation of GESS Participation

Fig 2.1 shows the distribution of GESS participants with respect to estimated propensity scores. The upper half of the graph refers to the propensity scores of treatment group, while the bottom half shows the propensity scores of the control group. The y-axis refers to the densities of the estimated propensity scores. As depicted in Fig. 2.1, the distribution of the propensity scores of the matched and unmatched individuals in both groups(GESS participants and non-participants) clearly exhibited considerable overlap in the common support region. However the figure also indicated that there are individuals out of the common support. The result of the binary logistic regression is presented in Appendix 2.2.

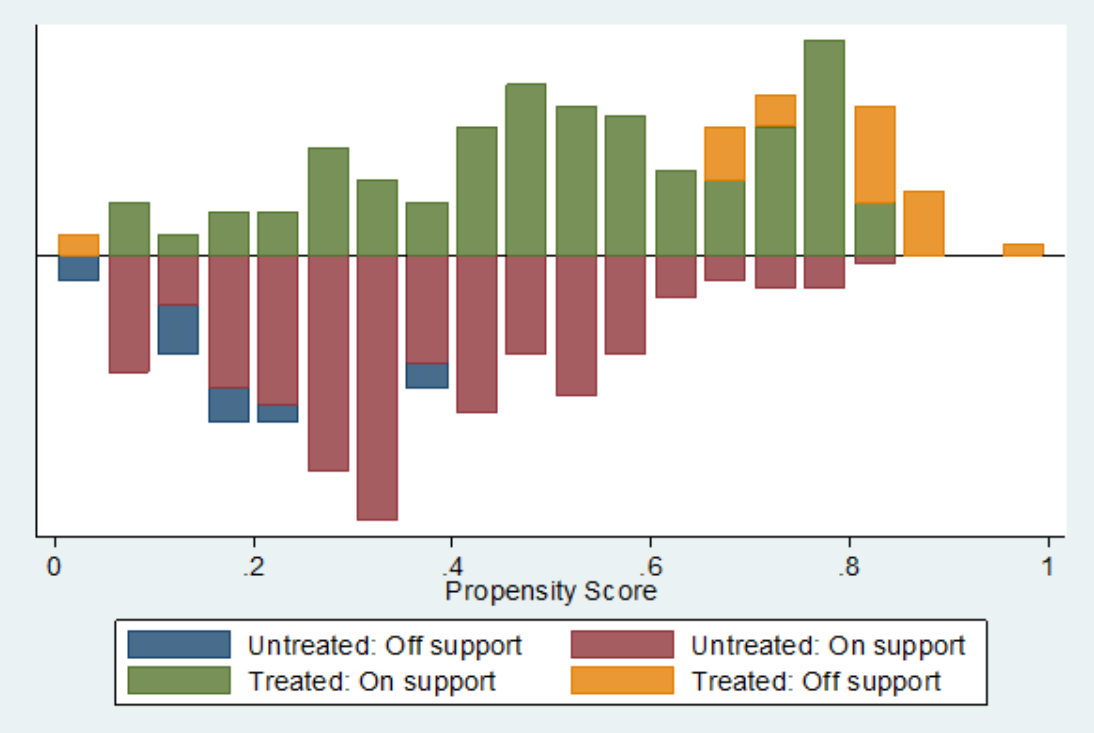

Figure 2.1: Distribution of estimated propensity scores for treatment, control groups and Common support using kernel matching

The estimated propensity scores vary between 0.04211 and 0.99312 (mean= 0.53011) and 0.03119 and 0.81323 (mean=0.34022) for the treatment and control groups respectively. The common support region would the lie between 0.04211 and 0.81323, thus the balancing property was satisfied. Accordingly, off support samples were discarded from the analysis in estimating ATET in both groups. Thus about 82% of participants and non-participants were in the common support area, showing substantial overlap between the two groups. Table 2.5 shows the balancing test of each matching algorithm before and after matching. The results show that the mean standardized bias is reduced from 26.3 to 26.9 before matching to 7.3 to 6.1 after matching with the three matching algorithm Similarly, pseudo R^2 decreases substantially from 21.9% before matching to a range of 0.2% to 0.5% after matching. The likelihood ratio test indicates that the joint significance of all variables before matching was insignificant after matching suggesting that individuals in the two groups are comparable. Furthermore, the total bias between GESS

participants and non-participants significantly decreased in the range of 56.7% when nearest method matching was used to 86.2% with kernel matching. Thus, the test clearly shows that the matching process balanced the observed characteristics between participants and non-participants groups after matching and are therefore comparable, in this case the matching GESS participants with non-participants is satisfactory (Ali and Abdulai, 2010) see Appendix 2.3.

Table 2.5: Propensity scores matching quality test (before and after matching)

	Pseudo R^2		LR Chi^2		P ¿chi^2		Standardizes mean bias		
Matching Algorithm	**Before matching**	**After matching**	**Before matching**	**After matching**	**Before matching**	**After matching**	**Before matching**	**After matching**	**Total % Bias reduction**
Nearest Neighbor	0.219	0.047	92.1	10.11	0.001	0.332	26.3	7.3	56.7
Kernel matching	0.213	0.023	108.56	8.88	0.000	0.782	26.4	6.1	86.2
Caliper matching	0.219	0.017	101	11.21	0.003	0.413	26.9	6.7	58.1

2.4.2.1 The treatment effect of GESS subsidy on maize productivity after correcting for selectivity bias by matching methods

Using Nearest neighbor matching, Kernel matching and Radius matching methods, the ATT results from PSM are presented in Table 2.6. The paper presents the average treatment on the treated (ATT), which is the parameter of interest because it is estimated by averaging within-match differences in the yields between the treatment and the control group. The result reveal that the average increased in maize yield of participating households significantly increased within the range of 512.59 kg/ha when Kernel matching was used to 524.97kg/ha when nearest neighbor matching was used representing 21% to 24.5% increase in maize yield. Similar findings on the impact of GESS on maize productivity have been reported by (Oguniyi *et al*., 2017; Wossen *et al.,* 2017; Adenegan *et al.,* 2018).

Table 2.6: The estimates of the impact of GESS subsidy on maize yield after correcting for selection bias (ATT)

Matching Algorithm	Participants	Non-participants	Difference	% yield difference	S. Error value	t-value
Nearest Neighbor	2115.07	1690 .20.	524.97	21.1	37.34	8.22***
Kernel Matching	2118.77	1605.18	512.59.	24.2	49.68	7.62**
Caliper matching	2118.80.	1600.28	518.80	24.5.	40.56	5.89**

2.4.2.2 Results from IV-two stage least square estimation

The result from Durbin (score) Chi^2 and Wu-Housman-F-statistics test of endogeneity indicates that GESS programme is endogenous at $P \leq 0.05$ level. Therefore, OLS estimation would lead to bias and inconsistent estimate of treatment effect. Moreover, the Hansen-j-test minimum Eigen value of 53.2 is greater than the value of nominal Wald test at $P \leq 0.05$ bias tolerance indicating that the instruments are exogenous. The R^2 value of 0.7778 shows that the variation in yield is well explained by the linear model. Some demographic variables and institutional factors have the expected signs and their influence have high statistical significance. The results show that the coefficient GESS subsidy is 37.7% ($e^{0.32}-1$¿ and is positive and statistically significant at ($P \leq 0.05$), Indicating that holding other factors constant, GESS subsidy programme increase maize yield of participants by 37.7%.

Looking at other variables in the model, the coefficient of sex suggests that the maize yield of male headed households was 23.4% higher than their female counter part holding other factors constant. This is not to suggest that GESS is bad per se, but rather that GESS is not sufficient in addressing the male-female productivity gap. This is not surprising because women face more barriers when accessing productive resources and technologies in Africa (Doss, 2001). Karamba and winters (2015) also found that FISP had no significant impact on productivity of female headed households in Malawi. This has

implication for women empowerment. It is well known that productivity stimulates poverty reduction; this places females at a disadvantage in terms of poverty reduction opportunities as compared to males. Therefore, factors that shape power dynamics in the household such as socio-cultural norms should be addressed to empower female household.

The coefficient of age squared was also statistically significant indicating that as farmers gets older the effect of impact becomes more pronounced holding other factors constant. Although this variable could not be determined apriori. This finding is contrary to the generally understanding that aging agricultural labour force decreases farmers' productive efficiency. Guo *et al*. (2015) examined the impact of aging agricultural labour on the production of farm output in China and found that elderly people who do not intend to abandon farming as the aged had higher agricultural output than others. Age influences farmers experience, older farmers are more experience and have greater efficiency in input use and farm management practices. This finding agreed with (Oguniyi *et al.*, 2017; Wossen *et al*., 2017) found that age of household head significantly increased maize yield and income of GESS participants in Nigeria. We also found a positive and statistically significant correlation between area cultivated and maize productivity, indicating that an increase in one hectare of area cultivated would increase maize productivity by 0.18% holding other factors the same.

However, we found a negative correlation between coefficient of extension visits per month and productivity after controlling for other factors. This result is based on empirical observation rather than theoretical deduction. First, this does not suggest that extension services decreased farmers' productivity but that this relationship is likely to be mediated or moderated by other variables captured or omitted from the model; hence data

analysis must have encountered estimation or measurement error. Secondly, it is possible that the variable was not well specified to capture the effect of extension on maize yield. Thirdly, Farmers no longer rely on agricultural extension agents for information regarding farming and marketing activities, they use a variety of information sources such as phones, radio, friends, relations and community organizations. Farmers are rational agents and would seek information where they consider beneficial and at a lower cost to them.

In a study by Gautama and Anderson (1999), they found that access to extension services had a negative and statistically significant impact on the value of maize production in Kenya. In another study, Ragasa *et al*. (2016) also examined the impact of Agricultural Extension services in the context of a heavily subsidized input system in Malawi and found that households who reported that they received very useful agricultural advice from friends and relations had greater productivity and food security than those who reported receiving advice from extension agents. Moreover, in the design of GESS programme, agricultural extension agents were not part of the stakeholders in the input supply chain. Farmers require extension services simultaneously with input supply to derive maximum benefits. For instance, a strong complementary synergy exists between input subsidy and agricultural extension services leading to joint positive effect on productivity. (Dorward and Chirwa, 2009) elaborates that complementary policies such as social cash transfer, infrastructure, research and extension services may strengthen the effectiveness of subsidy programs in Malawi.

The variable household size correlates positively with maize productivity at ($P \leq 0.05$) level of significance. This is as expected because crop production is labour intensive, hence larger households provides more labour for farming operations. In addition, the results from the 2SLS regression further show that the level of education, which is

measured by number of years of schooling, positively correlates with maize productivity, indicating that an additional year of schooling increases maize productivity by 30 % holding other factors the same. Higher education is associated with access to information and creates awareness about the available innovation and technology for improved productivity. This is consistent with findings from other researchers such as (Elibariki *et al*., 2008; Otitoju and Arene, 2010), who found that farmers with higher level of education tend to have higher efficiency in crop production. This is not surprising because farmers' productivity can be improved by improving workers' skill and greater investment in physical capital. There is the need for more research on the type of education farmers required to improve their productivity.

In addition, we also found that the coefficient of membership of commodity association is positively correlates with maize productivity. This result is as expected because farmer's association is a measure of the role of community relation and social organizations in the production process. Farmers access to institutions or social support is also an important asset as it complements other forms of capital in improving livelihoods. Accordingly, Durlauf and Fafchamps (2004) broadly describe social capital as entailing three main underlying ideas: (1) social capital generates positive externalities for members of a group; (2) these positive externalities are achieved through shared trust, norms, and values and their consequent effects on expectations and behavior; (3) shared trust, norms, and values arise from informal forms of organizations based on social networks and associations. When farmers come together, they pool all manner of collective resources for their collective gain. In most cases, they receive viable information on production technologies and access to input and output market from their association or groups.

We found statistically significant but negative correlation between distance to market and productivity. Distance from village to market or farm is an indicator of time taken to

reach the market or farm by road; it's also an indication of road condition as well as the length of the road. This result is as expected because distance increases cost to farmers and limits their degree of market participation. Olagunju and Adebayo (2015) assessed the impact of rural infrastructure on farm productivity and rural poverty in Nigeria and found that poor road network limit farmer's productive potential and increases poverty levels among households. However, this is contrary to (Kinuthia,2020) who examined the factors affecting crop production under Tanzania NAIVS programme and found that distance from farm to road is positively correlated with yields at the 1 per cent level implying better market access for farm produce in Tanzania. This call for more expenditure on road infrastructure to cut down transport costs to farmers thereby increasing the farmers' productivity and encourage farmers' market participation .There is the need to promote better market access for agricultural products.

Looking at the results in Table 2.6 and 2.7, we can conclude that, apart from slight differences in magnitude between PSM and 2SLS-IV estimates, GESS subsidy programme on average increase maize productivity and the findings are robust with the two methods of analysis. The results are also consistent and comparable with findings from Nwalieji *et al.* (2015); Olagunju and Adebayo (2015); Wossen *et al.* (2017) who examined the impact of GESS on productivity of smallholder farmers in different states in Nigeria and found that GESS subsidy increased crop productivity of smallholder farmers. However the findings are contrary to Kato (2016) who found that the NAIVS programme had no impact on maize yields in Ruvuma region because of poor design and implementation of the programme in Tanzania.

Table 2.7: Results of 2SLS-IV estimation of maize productivity dependent variable: log maize yield

Explanatory variables	Coefficient	Standard error	z	P>|z|
GESS participation	0.318 **	0.1245	2.81	0.033
Age of household head	0.299*	0.165	1.82	0.069
Age squared	0.0434**	0.0189	2.29	0.022
Household size(AE)	0.2573***	0.072	3.54	0.000
Sex	0.234	0.091	2.57	0.025
Number of extension visits	-0.143	0.226	-0.63	0.528
Membership of commodity association	0.315	0.504	0.62	0.533
Years of education	0.124 ***	0.031	4.05	0.001
Household land holding	0.198*	0.113	1.75	0.080
Area cultivated	0.061*	0.032	1.93	0.054
Distance to market	-0.057*	0.034	-1.68	0.093
Constant				
Number of observations	390			
Prob > chi2	0.0000			
R-squared	0.7733			

Durbin score chi ^{2} =0.002* Wald chi2 (11)/ F-Statistics= 118.19 Wu-Hausman= 0.002, Jargan-Hansen statistics =53.2*** ***p < 0.01, **p < 0.05, *p < 0.1**

2.5 Summary and Conclusion

In Nigeria, increasing agricultural productivity through the use of fertilizer and improved seeds is imperative to improving food security and reduce the pervasive nature of rural poverty. The study examined the impact of GESS subsidy programme on productivity of smallholder maize farmers using cross-sectional household survey data collected from 390 farming households from Kano state. The result from PSM showed that GESS subsidy increased maize yield of participating households between 512.59 kg/ha and 524. kg/ha based on matching method. While the result from 2SLS models which is the model with causal interpretation shows that GESS subsidy increase maize yield of participating households by 37.7%. Other determinant of maize productivity includes land size, years of schooling, membership of commodity association, household size, age and sex of the household head. While distance to market was found to correlate negatively with maize productivity. However, because of the sample size and the number of households that received vouchers, these results should be interpreted with caution. The finding is

significant for two reasons: first, maize is an important food crop for smallholders in Northern Nigeria. Secondly, the use of modern farm inputs is probably one of the options available to increase food production and reduce poverty in Kano. First, the study recommended that while education is important for enhancing maize productivity, further research is needed on the nature of education that is required to improve rural livelihood, Secondly, increasing public investment on rural road by increasing road density and distance to farm and market will have serious implication for agricultural productivity. Finally, public recognition and support to farmers' cooperatives will address some of the binding constraints to maize productivity in the study area.

References

Abdoulaye, T., Wossen, T. and Awotide, B. (2018). Impacts of improved maize varieties in Nigeria: ex-post assessment of productivity and welfare outcomes. *Food Security* 10(2): 369-379.

Adenegan, F., Kemisola, O., Fagbemi, O. and Osanyinlusi, I. (2018). Impact of the 'Growth enhancement support scheme (GESS) on farmers' income in Oyo state, Nigeria. *The Journal of Developing Areas* 52(1).

Akande, T. A., Djurfeldt, G. and Ogunleye, F. (2011). Has the Nigerian Green Revolution veered off –track? African Smallholders: Food, crops, Market and policy. Wallington CAB International.

Alabi, R. A. and Adams, O. O. (2020). The Impact of E-Wallet Fertilizer Subsidy Scheme and its Implication on Food Security in Nigeria. AERC Research paper 390. African Economic Research Consortium, Nairobi, Kenya.

Ali, A. and Abdulai, A. (2010). The Adoption of Genetically Modified Cotton and Poverty Reduction in Pakistan. *Journal of Agriculture Economics* 61(1): 175-192.

Aloyce, G. M., Gabagambi, D. M. and Hella, J. P. (2014). *National Agricultural Input Voucher Scheme Impact on Productivity and Food Security of Smallholder Farmers in Tanzania* ISSN 2222-1700 (Paper) ISSN 2222-2855 (Online) Vol. 5, No. 21, 2014.

Amani, A. A., Alamu, J. F. and Kudi, Y. M. (2010). Effect of fertilizer liberalization on maize production in Nigeria. *Journal of Development and Agricultural Economics* 2: 401-405.

Amare, M., Jennifer, D., Nathaniel, D. and Bakele, S. (2017). The Impact of Agricultural Productivity on Welfare Growth of Farm households In Nigeria: A panel Data

Analysis. Partnership for Economic Policy (PEP), Cornell University ,School of Applied Economics and Management ,Ithaca, New York,14853, USA.

Ayinde, O. E., Olaoye, I. J., Bolaji, M. O. and Oloyede, A. O. (2019). Politics in fertilizer subsidy implementation and governance structure towards agricultural and economic Development in Nigeria: *a review. Invited paper presented at the 6th African Conference of Agricultural Economists*, September 23-26, 2019, Abuja, Nigeria.

Banful, A. B. (2011). Old Problems in the New Solution? Politically motivated allocation of program benefits and the "new" fertilizer subsidies. International Food Policy Research Institute (IFPRI) available at [http://www.ifpri.org/publication/ old-problems-new-solutions] site visited on 12 May 2019.

Caliendo, M. and Kopeinig, S. (2008). Some Practical Guidance for the Implementation of Propensity Score Matching. *Journal of Economic Surveys* 22(1): 31–72.

Chirwa, E. and Dorward, A. (2013). *Agricultural Input Subsidies: The Recent Malawi Experience*. Oxford University Press. 74pp.

Dorward, A. and Chirwa, E. (2009). The Agricultural Input Subsidy Programme 2005 to 2008: Achievements and Challenges, [http://eprints.soas.ac.uk/8897/1/ Issues% 20Paper%2010%20Jun%20Rev%20A.pdf] site visited on 21/8/2019.

Doss, C. (2001). The role of women in Agriculture: closing the gender gap for development. ESA working paper no: 11-02. Agricultural Development Economics Division, FAO. [www.fao.org/economics/esa] site visited on 20/8/2019.

Druilhe, Z. and Barreiro-Hurlé, J. (2012). Fertilizer Subsidies in Sub-Saharan Africa. Agricultural Development Economics Division Food and Agriculture Organization of the United Nations. [www.fao.org/economic/esa] site visited on 13 May, 2017.

Elibariki, M., Shuji, H. and Nariu, T. (2008). Explaining productivity variation among smallholder maize farmers in Tanzania. In: *Proceedings of the World Congress of Rural Sociology of the International Rural Sociology Association*. 33pp.

Eva, G. (2018). *Income Intervention Quick Scan: Agricultural Input Subsidies; Farmer Income Lab Intervention Quick Scan.* Wageningen Centre for Development Innovation, Wageningen University and Research. Report WCDI-18-029. Wageningen.

Fadairo, O. S., Olutegbe, N. S. and Tijani, A. M. (2015). Attitude of crop farmers towards e-wallet platform of the growth enhancement support scheme for input delivery in Oke-Ogun area of Oyo State. *Journal of Agricultural Informatics* 6(2): 62–71.

Fan, S., Ashok, G. and Sukhaseo, T. (2008). Investment, Subsidies and Pro-poor growth in Rural India. *Agricultural Economics* 39(2): 163–170.

FAO. (2011). Current world fertilizer trends and outlook to 2015. Food and Agriculture Organization of the United Nations, Rome, Italy. 77pp.

Gautam, M. and Anderson, J. R. (1999). *Reconsidering the evidence on returns to T and V extension in Kenya*. The World Bank. 34pp.

Heckman, J., LaLonde, R. and Smith, J. (1999). The Economics and Econometrics of Active Labor Market Programs. *Handbook of Labor Economics* 3: 1865–2097.

Hemming, D. J., Chirwa, E. W. Dorward, A., Ruffhead, H. J., Hill, R., Osborn, J., Langer, L., Harman, L., Asaoka, H., Coffey, C. and Phillips, D. (2018). Agricultural Input Subsidies for Improving Productivity, Farm Income, Consumer Welfare and Wider Growth in Low and Lower Middle Income Countries: A Systematic Review'. *Campbell Systematic Review* 14(1): 1–153. https://doi.org/ 10.4073/ csr.2018.4.

Hemming, D. J., Chirwa, E. W. Dorward, A., Ruffhead, H. J., Hill, R., Osborn, J., Langer, L., Harman, L., Asaoka, H., Coffey, C. and Phillips, D. (2018). Agricultural Input Subsidies for Improving Productivity, Farm Income, Consumer Welfare and Wider Growth in Low and Lower Middle Income Countries: A Systematic Review'. *Campbell Systematic Review* 14(1): 1–153. https://doi.org/ 10.4073/ csr.2018.4.

Houssou, N., Johnson, M., Kolavalii, S. and Addo, C. A. (2017). Changes in Ghanaian Farming Systems: Stagnation or a Quiet Transformation? *Agriculture and Human Values* 35: 41–66. https://doi.org/10.1007/s10460-017-9788-6.

Ibitunde, I. O., Adereti, F. O and Farinde, A. J. (2019). Inputs accessibility and effectiveness of Growth Enhancement Support Scheme (GESS) in Southwest Nigeria. *Scientific Papers Series-Management, Economic Engineering in Agriculture and Rural Development* 19(3): 281-289.

Ibrahim, H. Y. I., Ale-ojo, H. A. I. and Wahab, M. J. (2018). Impact of the Growth Enhancement Support Scheme (GESS) on Maize Farmers in Dutsinma Local Government Area of Katsina State, Nigeria, FUDMA. *Journal of Sciences* (*FJS*) 2: 143-148.

IDEP (2011). Towards improved fertilizer subsidy programme in Nigeria. Drawing lessons from promising practices in SSA. Available on the internet at [http://www.npc.gov.ng/vault/files /IDEP%20Study%20doc.pdf] site visited on 12-04-2017.

Jayne, T. S. and Rashid, S. (2013). Input subsidy programs in Sub-Saharan Africa: a synthesis of recent evidence. *Agricultural Economics* 44: 547-562.

Jayne, T. S., Mather, D., Mason, N. and Ricker-Gilbert, J. (2013). How do fertilizer subsidy programs affect total fertilizer use in sub-Saharan Africa? Crowding out, diversion, and benefit/cost assessments. *Agricultural Economics* 44(6): 687-703.

Jerven, M. (2014). The Political Economy of Agricultural Statistics and Input Subsidies: Evidence from India, Nigeria and Malawi. *Journal of Agrarian Change* 14(1): 129-145.

Kamara, A. (2004). The impact of market access on input use and agricultural productivity: Evidence from Machakos District, Kenya. *Agrekon* 43: 23-39.

Karamba, R. W. and Winters, P. C. (2015). Gender and agricultural productivity: implications of the Farm Input Subsidy Program in Malawi. *Agricultural Economics* 46(3): 357-374.

Kassie, M., Jaleta, M., Shiferaw, B. A., Mmbando, F. and De Groote, H. (2012). Improved maize technologies and welfare outcomes in smallholder systems: evidence from application of parametric and non-parametric Approaches. Selected Paper prepared for presentation at the International Association of Agricultural Economists (IAAE) Triennial Conference, Foz do Iguaçu, Brazil, 18-24 August, 2012.

Kato, T. (2016). Agricultural Input Subsidies in sub-Saharan Africa – The Case of Tanzania. Doctoral Thesis (PhD) for Award Degree at Brighton: University of Sussex. 320pp.

Liverpool-Tasie, L. S. (2013). Do Vouchers Improve Government Fertilizer Distribution? Evidence from Nigeria. *Agricultural Economics* 45(4): 393–407.

Liverpool-Tasie, L. S. and Takeshima, H. (2013). Input Promotion within a Complex Subsector: Fertilizer in Nigeria. *Agricultural Economics* 44(6): 581–594.

Liverpool-Tasie, L. S. O., Omonona, B. T., Sanou, A. and Ogunleye, W. O. (2017) .Is Increasing Inorganic Fertilizer Use for Maize Production in SSA a Profitable Proposition? *Evidence from Nigeria, Food Policy* 67: 41-51.

Masinjila, S. and Lewis, L. (2018). The Future of Smallholder Farmer Support in Tanzania: Where to After National Agricultural Input Voucher System (NAIVS)?'. Technical Report. Johannesburg: African Centre for Biodiversity.

Mason, N. M. and Ricker-Gilbert, J. (2013). Disrupting demand for commercial seed: Input subsidies in Malawi and Zambia. *World Development* 45: 75-91.

Mohammed, A. I. (2017). *Farm credit, farmland, farm infrastructure and agricultural output in Kano State, Nigeria: the moderating effect of murabahah finance*. Doctoral Dissertation for Award Degree of PhD. at Universiti Utara Malaysia. 142pp.

Motilewa, B. D., Worlu, R. E. K., Adepoju, Y. and Fayomi, O. O. (2015). *Interrogating the Citizen-Centered Services and Development in Nigeria's Agricultural Sector Through E-Governance*. Presented at Covenant University Conference on E-governance in Nigeria. 21pp.

Nagy, J. G. and Edun, O. (2002). Assessment of Nigerian Government fertilizer policy and suggested alternative market friendly policies. At [http://pdf.usaid.gov/ pdf_docs/ PNADB846.pdf] site visited on 20/09/2019.

NBSN (2010). Nigeria poverty profile [availableonlinet:http://www.nigerianstat. gov.ng/pdfuploads/Nigeria%20Poverty%20Profile%202010.pdf.NPC] site visited on 14 May, 2017

Nwalieji, H. U., Chukwuemeka, O. O. and Uzuegbunam, C. O. (2015). An Assessment of Growth Enhancement Support Scheme among Rice Farmers in Anambra State, Nigeria. *Journal of Agricultural Extension* 19(2): 71-81.

Oguniyi, A. and Kehinde, O. (2015). Impact of Agricultural Innovation on Improved Livelihood and Productivity Outcomes among Smallholder Farmers in Rural Nigeria. A paper prepared for presentation at the 5th MSM 5th Annual Research Conference Managing African Agriculture: Markets, Linkages and Rural Economic Development. MSM, Maastricht, The Netherlands. 4 September 2015.

Ogunniyi, A., Oluseyi, O. K., Adeyemi, O., Kabir, S. K. and Philips, F. (2017). Scaling up agricultural innovation for inclusive livelihood and productivity outcomes in sub-Saharan Africa: The case of Nigeria. *African Development Review* 29(S2): 121-134.

Ogunniyi, A., Omonona, B., Abioye, O. and Olagunju, K. (2018). Impact of irrigation technology use on crop yield, crop income and household food security in Nigeria: A treatment effect approach. *AIMS Agriculture and Food* 3: 154–171

Olagunju, K. and Adebayo, O. (2015). The Assessment of the Impact of Rural Infrastructure on Rural Poverty in Nigeria. *Economica* 8(3): 1585-6216.

Olatohun, I. I., Jimoh, F. A. and Oke, A. F. (2019). Effectiveness of Growth Enhancement Support Scheme (GESS) in Input Delivery in Southwest Nigeria. *Asian Journal of Agricultural Extension, Economics and Sociology* 2019: 1-11.

Otitoju, M. A. and Arene, C. J. (2010). Constraints and determinants of technical efficiency in medium-scale soybean production in Benue State, Nigeria. *African Journal of Agricultural Research* 5(17): 2276-2280.

Priscilla, W. W., Julius, J. O. and Jonathan, N. (2012). Impact of contract farming on smallholder poultry farmers' income in Kenya, Department of Agricultural Economics University of Nairobi P.O. Box 29053, Nairobi, Kenya: Paper prepared for presentation at the International Association of Agricultural Economists (IAAE) Triennial Conference, Foz do Iguaçu, Brazil. pp. 18-24.

Ragasa, C. and Mazunda, G. J. (2018). The impact of agricultural extension services in the context of a heavily subsidized input system: The case of Malawi. *World Development* 105: 25-47.

Ricker-Gilbert, J. (2014). Wage and employment effects of Malawi's fertilizer subsidy programme. *Agricultural Economics* 45(3): 337–353.

Ricker-Gilbert, J. and Jayne, T. S. (2017). Estimating the enduring effects of fertilizer subsidies on commercial fertiliser demand and maize production: panel data evidence from Malawi. *Journal of Agricultural Economics* 68(1): 70-97.

Ricker-Gilbert, J., Jayne, T. S. and Chirwa, E. (2011).Subsidies and crowding out: A double-hurdle model of fertilizer demand in Malawi. *American Journal of Agricultural Economics* 93(1): 26–42.

Rosenbaum, P. R. and Rubin, D. B. (1983). The central role of the propensity score in observational studies for causal effects. *Biometrika* 70: 41–55.

Rosenbaum, P. R. and Rubin, D. B. (1985). Constructing a control group using multivariate matched sampling methods that incorporates the propensity scores. The American Statistician The central role of the propensity score in observational studies for causal effects, *Biometrika* 70: 41–55.

Shively, G. E. and Ricker-Gilbert, J. (2013). Measuring the impacts of agricultural input subsidies in Sub-Saharan Africa: Evidence from Malawi's farm input subsidy program. *Purdue Policy Research Institute (PPRI) Policy Briefs* 1(1): 1-4.

Shively, G., Chibwana, C., Fisher, M., Jumbe, C. and Masters, W. (2012). Measuring impacts of Malawi's farm input subsidy program. Paper presented at the International Conference of Agricultural Economists. Foz du Iguacu Brazil, 20 August 2012.

Sianesi, B. (2004). An evaluation of Swedish system of active labour market programmes in the 1990s. *Review Economic Statistics* 86(1): 133-155.

Stein, H. and Lunduka, Z. (2012). Who Benefit from Malawi's Targeted Farm Input Subsidy Program? *Forum for Development Studies* 20: 60-75. DOI:10.1080/ 08039410. 2012.688858.

Takeshima, H and Liverpool-Tasie, L. S. O. (2015). Fertilizer subsidies, political influence and local food prices in sub-Saharan Africa: Evidence from Nigeria. *Food Policy* 54: 11-24.

Uduji, J. I., Okol-Obasi, E. N. and Asongu, S. A. (2019) .Growth Enhancement Support and Farmers Fertilizer use in Rural Nigeria. *African Development Review* 31(3): 348-363.

Wang, S. W., Manjur, B., Kim, J. G. and Lee, W. K. (2019). Assessing Socio-Economic Impacts of Agricultural Subsidies: A Case Study from Bhutan'. *Sustainability* 11: 32-66. https://doi.org/10.3390/su11123266

Winter-Nelson, A. and Temu, A. (2005). Impacts of prices and transactions costs on input usage in a liberalizing economy: evidence from Tanzanian coffee growers. *Agricultural Economics* 33(3): 243-253.

World Bank (2007). World Development Report 2008: Agriculture for Development, Washington, DC: International Bank for Reconstruction and Development/ World Bank. 198pp.

Wossen, T., Abdoulaye, T., Alene, A., Nguimkeu, P., Feleke, S., Rabbi, I. Y. and Manyong, V. (2018). Estimating the productivity impacts of technology adoption in the presence of misclassification. *American Journal of Agricultural Economics* 101: 1–16.

Wossen, T., Berger, T. and Di Falco, S. (2015). Social capital, risk preference and adoption of improved farm land management practices in Ethiopia. *Agricultural Economics* 46: 81–97.

Wossen, T., Tahirou, A. A., Alene, S., Feleke, J., Ricker- Gilbert, V. M. and Bola, A. A. (2017). Productivity and Welfare Effects of Nigeria's e-Voucher-Based Input Subsidy Program. *World Development* 97: 251-265.

Yusuf, O. J. and Abdullahi, K. A. (2015). Effectiveness of e-wallet scheme in curbing sharp practices associated with agricultural input accessibility among smallholder farmers in Kano State, Nigeria. *Nigerian Journal of Rural Sociology* 15: 67-75.

CHAPTER THREE

3.0 Impact of GESS Subsidy Programme on Welfare of Smallholder Maize Farmers in Kano state, Nigeria.

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Abstract

Growth Enhancement Support Scheme (GESS) is a smart subsidy programme which was implemented with the primary aim of enhancing farmers' income and reduced poverty. Available studies have shown that GESS subsidy significantly decreased the probability of households falling below the income poverty line. However, Poverty is now widely recognized as a multidimensional phenomenon where no single indicator is able to correctly capture the multiple aspect of poverty. Against this backdrop, this study examined the impact of GESS subsidy using Alkire-Foster multidimensional poverty measure which looks at poverty in terms of education, health and living standard. The study used a two-stage sampling design with stratification to draw a representative sample of 170 GESS participants and 220 non-GESS participants to estimate treatment effect of

GESS. By way of analytical method, we employed Propensity Score Matching (PSM) and Binary Logistic Regression to estimate the impact of GESS on multidimensional poverty. Results show that, based on the education, health and living standard dimensions of poverty, the poverty incidence in Kano is still quite high (64%). The results from PSM shows that GESS subsidy significantly decreased MPI within the range of 0.05 to 0.06, representing between 15.6% and 19.4% decrease in MPI depending on the matching methods. Results from the Binary Regression with instrumental variable method shows that GESS significantly decrease the probability of households to be MPI poor by 16.8 percentage point after controlling for other factors, the impact was significant at $p \leq 0.1,$ implying that impact of GESS on MPI was weak, implying that the programme had little effect on farmers' welfare. Therefore, the analysis of poverty should be multidimensional rather than focusing on economic deprivations. The findings also show that off farm income, market participation, age of household head, education level and membership of commodity association negatively influence MPI. These factors ought to be accorded priority in subsequent design of agricultural development programmes. The study recommended that to be able to improve the wellbeing of rural households, first, it would also require the development of the non-farm sector. Secondly, effective targeting of poor households should be promoted by up scaling appropriate input delivery systems and finally, more investment in infrastructure such as access to sanitation, healthcare, drinking water, and electricity is needed to improve the quality of rural life.

Key words: GESS subsidy, Maize farmers and Multi-dimensional Poverty Index, Kano State.

3.1 Background to the Study

Farm input subsidies have a huge potential for providing incentives to farmers to use inputs that they are unable to purchase at prevailing market prices (Dorward *et al*., 2014; Hemming *et al*., 2018). In Sub-Saharan Africa, farm subsidies are seen as means for achieving productivity growth, food security and poverty reduction (Liverpool-Tasie and Takeshima, 2013; Jayne *et al*., 2013; Okoh, 2018).

Agricultural input subsidies were a major component of agricultural development agenda in sub-Saharan Africa (SSA) in the 1970s and 1980s (Shively and Ricker-Gilbert, 2013). They were fiscally unsustainable and also reduced expenditure on public goods. Farm subsidies were later largely phased during structural adjustment programmes in the 80s and 90s. However, in the last two decades, farm input subsidy programmes re-emerged across the African continent, and their reintroduction gained momentum from the first African Fertilizer Summit, which was held in Nigeria in 2006. The rationale for the re-emergence of farm input subsidy programmes was to correct the mistakes of the past subsidy programmes. The approaches taken in the 70s and 80s relied on universal coverage, which was costly and spread benefits beyond intended groups (Shively and Ricker-Gilbert, 2013; Adenegan *et al*., 2018). The programmes are rebranded as “smart subsidies” because they rely on new institutions and innovations to improve programme implementation, encourage private sector development and more accurately target intended beneficiaries (Liverpool-Tasie and Takeshima, 2013).

Fertilizer subsidy remains a key policy instrument used by Nigeria Government to boost productivity and small-scale farm holder household’s income in ensuring pro poor growth and development. Despite, subsidy huge financial implication, government has been revitalizing and changing it policy approach to ensure greater impact and target (Ayinde *et*

al., 2019). In 2011, the Nigerian Government implemented the Growth Enhancement Support Scheme (GESS) in all the thirty-six states of the federation including Abuja Federal Capital Territory (Olomola, 2015; Wossen *et al*., 2017). The programme was implemented with the broad official objective of promoting agricultural productivity and food security by making fertilizer and improved seed more affordable and accessible to smallholders (Chirwa and Dorward, 2013; Liverpool-Tasie and Takeshima, 2013). GESS involved private agro-dealers in the procurement and distribution of fertilizer and improved maize seeds in order to simultaneously develop input market. GESS was designed to reach 20 million farmers with two kg bags of 2 fertilizer (NPK and Urea) and 25kg bag of improved maize seeds through mobile phone technology within five years. The (FMARD, 2014) claimed that no fewer than 10 million farmers were captured in the database of the Growth Enhancement Support (GESS) in 2014 and in 2015 farming season 13 million farmers received subsidized fertilizers and improved maize seeds.

Most of the farm input subsidy programmes (FISP) being implemented in Sub-Saharan Africa includes raising farm incomes and reducing rural poverty (Mason and Tembo, 2014). Indeed, it is sometimes suggested that FISP in Nigeria have had little impact on rural poverty because the countries' rural poverty rates remain unchanged despite many years of subsidy programmes (Liverpool-Tasie and Takeshima, 2013). Literature is replete with studies on impact of GESS subsidy on household welfare focusing on income, food security and income poverty using various empirical approaches (Ahmed *et al*., 2016; Oluwafemi, 2016; Wossen *et al.,* 2017; Okoh, 2018; Adenegan *et al.,* 2018). These studies reported that GESS decrease the probability of households falling below the income poverty line. However, these studies were only based on income as a single indicator of poverty. Alkire and Santos (2014) argued that no single indicator such as income is able to correctly capture the multiple dimensions of poverty. The studies did not show whether

households' income is used to improve livelihood outcomes such as health, education and household assets that improves the quality of life. Different types of income may be controlled by different persons within the household and used for different purposes (Meemken *et al*., 2017; Ogutu and Qaim, 2018). Hence the assumption that income earned from GESS subsidy will automatically be spent on satisfying basic needs may not always be true. How income and purchasing power from subsidy programmes increase expenditure on improving livelihood outcomes such as health, education, nutrition, household assets is not well documented in impact literature.

Alkire-Foster (2014) maintained that a multidimensional approach should complement income-based approach whereby, while income based approach focused on income poverty a multidimensional approach focuses on acute poverty. The debate on whether the income-based approach should complemented by a multidimensional approach in targeting policy reduction policies as well as 2030 global goal for sustainable development remains inconclusive (Burchi *et al*., 2018).

Alkire-Foster (2011) developed the MPI which captures a wider scope of factors that contribute towards improving the quality of life experienced by household members. MPI assesses directly whether or not different types of basic needs are actually satisfied. Few impact evaluation studies have aplied the MPI highlighting the need for further research on how MPI can be applied to this area of study. Therefore this study examined used the Alkire-Foster MPI as an indicator of welfare to examine the impact of GESS subsidy on smallholder maize farmers in Kano State. The contribution of this study to literature lies particularly in the analysis of the impact of GESS on multidimensional poverty. The main research question of the study: what is the impact of GESS subsidy on multidimensional

poverty of smallholder maize farmers in Kano State? We further analyze the relationship between income variables and MPI measures to establish the impact pathway.

This study is justified because of the effort of the Federal Government of Nigeria in the on-going transformation of the nation’s agricultural sector and recognition of farm subsidies as the means through which the wellbeing of poor farmers can be improved.

3.2 Research Methodology

3.2.1 Study area and data collection

A cross-sectional household survey data was conducted in Kano State, Northwest, Nigeria from July to November 2017. A two-stage sampling design with stratification was used to random sample 30 of GESS beneficiary villages and 390 households in Kano State. The list of villages and households was collected from Kano Agricultural Development Agency and village extension offices respectively. The sampled households were interviewed using a semi-structured questionnaire which was designed and pretested before the actual survey. Semi structured questionnaires were used to elicit farmers' responses on socio-economic characteristics of the households, consumption expenditure, household income and income sources, output and input prices food security and household assets. The participants and non-participants were drawn from the same villages and the same data collection instrument was used to elicit responses on crop output, consumption and other livelihood outcomes from both groups. However, inability to maintain the same population size for each stratum in the second stage suggest that sampling size may not be probability proportional to size hence we acknowledge difficulties in selecting a truly representative sample (Table 1.1).

3.2.2 Measuring household welfare

Poverty reduction and food insecurity is the goal of all agricultural subsidy programmes embarked upon by the Nigerian government. This is important because these issues pose serious challenge in Nigeria and the rural areas are mostly affected .These indicators were chosen because policy makers consider them relevant when designing welfare programmes. We began by describing the structure of household income in order to find the association between household income and MPI then we constructed the MPI based on AF method. We then examine the direct effect of GESS subsidy on multidimensional poverty index. Finally we examine the poverty reduction mechanism by checking empirical the relationship between income variables and MPI indices.

3.2.2.1 Household income

Household income depends on the allocation of total labour supply between on farm and off farm employment. The farmer receives income from two activities: working on his farm to receive the farm income and working in the labor market to receive wage income. Therefore to reflect the situation of the farmers' income, we identified three sources of household income: farm income, off farm and non-farm income sources were taken into account in the estimation of household income.

(a) Farm income:

Crop income

In this study crop income was estimated as net crop income. It was calculated as the quantities of all crops harvested (sold and unsold) valued at farm gate prices to reflect the opportunity cost of own consumption less cost of production. Farmers were asked to specify all costs incurred in crop production of all crops during the season under consideration. The cost of crop production includes cost of fertilizer purchased, hired labour, cost of transportation, imputed value of family labour, and cost of chemicals used.

The net crop income given by equation 1.

$$NCI_i = \sum_{J=1}^{J}\left[P_{ij}Y_{ij} - \left(P_{ij}X_{ij} - CF_{ij} - CH_{ij} - CT_{ij}\right)\right] \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

NCI_i = Net crop income of i[th] household , Y_{ij} = total output of crop j from household i[th] (quantity sold, consumed, in-kind payment for labour gift to friends and relations) , P_{ij} = farm gate price of crop j sold and unsold from household i[th], $P_{ij}X_{ij}$ = cost of input X used in the production of crop j from household i[th], CF_{ij} = imputed or opportunity cost of family labour for crop j from household i[th] which was imputed as average off farm wage in Naira per adult per day in the village , CH_{ij} = cost of hired labour calculated as wage of labour for crop j from household i[th] in naira per day , CT_i = cost of transportation in Naira per day for i[th] household.

Livestock income:

We estimated livestock income as the value of live and slaughtered animal and animal products (live animals, meat and, poultry, milk and eggs) sold and unsold less cost of production. The production cost includes imputed cost of family labour, management cost, and veterinary cost. Cost incurred in production vary with production system, however the variation in production system was not taken into account.

The net value of livestock is given by equation 2

N LI_i=¿ $\sum_{j=1}^{j}\left[\left(P_{ij}Q_{ij}\right) - \left(C_{ij}Q_{ij}\right)\right]$ …… ……..

(2)

N LI_i=¿ Net value livestock income from i[th] household, P_{ij} = farmgate price of unit of livestock, Product j from household i[th], Q_{ij} = Quantity of livestock product j (meat,

live animal, eggs, birds and milk) from household i, $C_{ij}Q_{ij}=¿$ Cost of producing j quantity of livestock product (cost of feeds, veterinary services, hired labour, equipment and, Management cost) from household ith

Net farm income:

We estimated net farm as the sum of net value of crop plus the sum of net value of livestock as in equation 3

$$NFI = NCI_i + NLI_i$$

……(3)

(b) Off farm income:

Off farm income includes income earned from sources such as off farm agricultural labour. GESS subsidy may have a potential effect on off farm activities .Off farm income gives a measure of whether or not GESS subsidy has any positive spillover effect that may encourage households to invest on other off farm activities. (Lunduka *et al*., 2013) found that households who sell their labor off farm experience some small spillover benefit from the program in the form of higher agricultural wage rates. It could be possible that GESS caused increased in production and income and encourage invest in other enterprises for the future.

(3) Non-farm income

This includes non-agricultural wages such as self-employment, informal wage or salaried income, profits from non- farm business enterprises, transfer, pensions, gifts received and remittances.

(4) Total household income

The effect of GESS subsidy on total household income provides overall measure of programme impact on household welfare. We estimated total household welfare as the sum of Net farm income; off-farm income and no farm income. We express total household income in per capita terms as in equation 5

$THI_i = NFI_i + OFI_i$ …….. (4)

$HIP_i = ¿ \frac{THI_i}{n_i}$ ……(5)

HIP_i = Household income per capita of ith household, n_i = household size of ith household Similar approach has been employed by Ricker-Gilbert and Jayne (2011) in examining the welfare impact of Malawian farm input subsidy programme.

3.2.2.2 Multidimensional poverty index

The MPI measures acute poverty by capturing information on the proportion of households within a given population that experience multiple deprivations and the intensity of their deprivation. The MPI was proposed by Alkire and Santos (2014) to assess directly whether or not different types of basic needs are actually satisfied. In this study, we closely followed the approach by Alkire and Santos (2014). However due to the weakness in research, data was not collected for indicator child mortality, hence we replaced child mortality with an indicator defined as food availability. Food availability is an indicator of food security which reflects the objective of GESS subsidy programme. Adjustment to fit the local content have been recommended in literature (Alkire and Foster, 2011; Alkire and Santos, 2014; OPHI, 2018) and adopted in some evaluation

studies such as (Adenuga, 2016; Ogutu and Qaim, 2018; Aboaba *et al*., 2019; Adeoye, 2019; Song and Imai, 2019; Isinika *et al.*, 2020).

The modification is that we did not use the “child mortality” and “if any child has died in the family?” we replaced this indicator with food availability, “if households do not take three meals per day.” The presence of nine out of ten indicators (all the three dimensions) more than meets the UNDP standard that the MPI should not be calculated when all indicators within a dimension or when 50% or more out of the 10 indicators are missing’ Kovacevic and Calderon (2014). The descriptions of all 10 indicators used in this study with the corresponding cutoffs are shown in Table 3.1.

Each indicator is a binary response (zero or One). Using the zero and one values for each of the 10 indicators, we calculate different MPI measures for GESS participants and non-participants. First we calculated the weighted deprivation score by summing up the weighted values of each of the 10 indicators, using weights as shown in Table 3.1. The total weighted deprivation scores ranges between 0 and 1, where larger values indicate higher levels of deprivation. Then secondly, we created a “multidimensional poverty dummy”, which takes a value of one if a household’s total deprivation score is equal to or larger than a certain threshold, and zero otherwise. The common threshold is 0.33 (Alkire and Santos, 2014). Hence, the overall MPI represents a proportion of the sample that is poor. Being a representative of the population from which the sample is drawn. The logic behind the MPI dummy is that a household is considered multidimensional poor only if it suffers from deprivations in terms of several indicators.

Table 3.1: The dimensions, indicators, deprivation cutoffs and weights of the MPI

Dimensions of poverty	Indicator	Deprived if	Relative weight
Education (1/3)	Years of Schooling	No household member aged 15 years or older have completed secondary schooling	1/6
	Child School Attendance	The household any school-aged child (7 -15) not attending school	1/6
Health (1/3)	Food availability	The household does not take three meals per day	1/6
	Nutrition	The household did not go to the farm due to sickness	1/6
Living standard (1/3)	Electricity	The household has no electricity	1/18
	Improved Sanitation	The household has pit latrine without slab/open pit/no facility/bush/field or other unspecified types of toilet facilities	1/18
	Safe Drinking Water	The household access to safe drinking water is from unprotected well, river/dam/lake/ponds/stream/canal/irrigation or other unspecified sources of drinking water or safe drinking water from home is at least a 30-minute walk from home round trip	1/18
	Housing condition	The household has earth, sand, wood plank or, thatched roof, mud walls another unspecified type of floor	1/18
	Cooking Fuel	The household cooks with Kerosene, wood, charcoal, straws/shrubs/grass, sawdust or another unspecified type of cooking fuels	1/18
	Assets Ownership	The household does not own more than one radio, television, refrigerator, bicycle, motorcycle/scooter or refrigerator and does not own a car/truck, phone, livestock	1/18

Notes: The indicators are very similar to those in Alkire and Santos (2014), except for modifications in one indicator (child mortality) as explained in the methodology.

The MPI indices are given by

$$H = \frac{q}{n} \quad H = \frac{Q}{n}$$

…… (7)

Where H= multidimensional head count ratio

Q= the number of people who are multidimensional poor and

n= the total population

While the MPI intensity (A) is specified as presented in equation

$$A = \frac{\sum_{i=1}^{n} c_i K}{Q}$$

…….. (8)

Where

A= Average intensity of poverty $C_i K$ = Censored deprivation score of household, ($C_i k$ $k=3$)

Q = The number of people who are MPI poor.

The MPI is then calculated by multiplying the incidence of poverty by MPI intensity

$MPI = H \times A$ …….

……..(9)

3.3 Analytical Framework and Estimation Techniques

3.3.1. Propensity score matching method

Farmers were not randomly selected to participate in GESS, therefore, the difference between the households may be due to variation based on the subsidy programme guidelines and observable demographic characteristics therefore by simply examining the difference in mean outcome between GESS participants and non-participants will not eliminate biases due to selection on observables (Imbens and Wooldridge, 2009). Therefore, we use comparison of samples with GESS and without GESS. Given that GESS participation is denoted by Z, where Z = 1 for participation and Z = 0 for non-participation. X is a set of observable household characteristics that explain participation in GESS subsidy Y_1 represents welfare outcome for participants and Y_0 welfare outcomes for non-participants. We can only observe Y_1 but not both. We estimated the propensity scores P ($Z = 1| x$) $\equiv\equiv$ $P(x)$ (propensity score) and used the average outcome

in the control group, $E(Y_0/z=1,X)$ to create a counterfactual. A careful selection of conditioning variables and a correct specification of the logistic regression are crucial to propensity score matching (Caliendo and Kopeinig, 2005; Guo and Fraser, 2015). Similar approaches have been adopted by (Awotide *et al.,* 2016; Ahmed *et al.,* 2017; Wossen *et al*., 2017).

Definition of the variables

The MPI is a customized measure constructed in accordance with (Alkire-Foster, 2011-2012; Alkire-Santos, 2014-2015). GESS participation is a dummy variable, equals to one if the household is a participant and zero if the household is not. As the MPI is a measurement of the state of poverty, a negative value would indicates a reduction in poverty and hence success of the program. We expect MPI to be negative (lower) for GESS participants.

Following impact evaluation literature and considerations on design and implementation process of GESS programme, we included a range of demographic, institutional and village level variables as control variables. They include continuous variables such as household size (in per adult equivalent), age, and years of schooling of the household head. Variables such as sex, access to credit, marital status, and phone ownership were all captured as dummies. These variables also serves as the observable characteristics used in the PSM method. They are considered exogenous to MPI. The binary logistic model is given by equation 10

$$P(X)=P[Z=1/X] = [Z/X;F(h/X_i)]$$

…….. (10)

F (.) is a logistic cumulative distribution and X is a vector of conditioning variables. In this study the variables used to construct the propensity scores are related to programme participation and welfare outcome (Caliendo and Kopeinig, 2005). The variables used in are defined in Table 3.2. We then matched GESS participants and non-participants on the basis on their propensity scores. We present the result of the quality of matching in Appendix 3.5. The ATT was estimated on the region of common support which requires that; 0<P (Z=1|X=x) <1 for all x contained in X for $x \in z$. We estimated our parameter of interest which is the average treatment effect on the treated (ATT) as in equation 11.

ATT= E ($Y_{i1,} - Y_{0i}$ |Z=1)=E(Y_1 |Z=1)-E(Y_0 |Z=1)

…… (11)

Table 3.2: Definition of the variables use in the estimation of propensity scores

Variable	Type and definition	Measurement	Expected sign
Dependent variable	Dummy, GESS participation	1 if yes, 0 otherwise	
Independent variables			
Sex_HH	Dummy, sex of household head	I if male,0 otherwise	+/-
Age_HH	Continuous ,age of household head	Full years of household head	+/-
Yrsedu_HH	Continuous ,number of years of education of household head	Number of years of formal schooling	+
HHsize	Continuous, household size	Number of all household members living in the house	+
Tlandhold	Total land holding of the household	I hectares	+
Dis_redemp	Distance to input redemption Centre	In kilometers	_
Dis_mkt	Distance to market	In kilometers	_
Num_ext	Number of extension visit	Number of extension visits per month	+
Accredit	Household access to credit	1 if household access credit ,0 otherwise	+/-
MStatus	Marital status of household head	1 if household head is married ,0 otherwise	+/-
Area maize	Area under maize cultivation	Total area in hectares	+
HH_labour	Household available labour	Number of active labour in the household	+
Phone own	Household own a mobile phone	If yes 1,0 otherwise	+

3.3.2 Binary logistics regression with IV method

PSM only eliminates bias due to selection on observables, following the impact assessment literatures. The most plausible assumption in this case is that of selection on unobservable (Imbens and Wooldridge, 2009; Awotide *et al.*, 2016). Since e-vouchers were distributed to households non-randomly (i.e. to only targeted households), unobserved household heterogeneity which may influence GESS participation may also influence households' poverty status. Thus GESS participation becomes endogenous in the estimations. As such, estimation of the impact of GESS may encounter identification problem if GESS participation (G) is correlated with ε_i such that $Cov(G, \varepsilon_i) \neq 0$ (Woodridge, 2010) estimation of the effect of (G) in equations 12 would lead to bias and inconsistent estimates of treatment effect. We used a binary logistic regression with Instrumental variable (IV) method to adjust for unobserved factors and estimate the conditional mean effects of GESS subsidy on multidimensional poverty index. We replaced (G) in equations 12 with propensity scores generated from first stage (equation 10) to control for potential endogeneity (Woodridge; 2010; Wossen *et al.*, 2017). This method is efficient even with weak instruments and it is preferred to other IV methods since our treatment variable is binary (Wooldridge, 2010). Similar approaches have been adopted by (Wossen *et al.*, 2017). However, this approach results in approximately consistent estimates of treatment effect if the structure of a generalized linear model is not explored (Carroll, 1995).

We capture MPI as a binary dependent variable equals to one if the household was identified as MPI poor or zero if otherwise. We specify a binary logistic model in instrumental variable method to obtain consistent estimate of the impact of GESS subsidy on MPI and its determinants as in equation 12.

$$Y^{¿} = \beta_0 + \beta_1 H_i + \beta_2 \widehat{G}_i + \beta_3 D_i \quad + \quad \varepsilon_i$$ …………………………………………………

(12)

Where, $Y_i^{¿}$ is a latent variable which represents multidimensional poverty index captured as binary dependent variables? H_i Is a vector of control variables which includes household and farm characteristics and includes sex, age, and number of years of education of household, farm size, maize area and market participation, D_i D_i is a vector representing distance to market. The variables are hypothized to influence Household income, income poverty and multidimensional poverty index. $\widehat{G}$ $\widehat{G}_i$ is GESS participation which is instrumented by propensity scores estimated from equation 9, β_s β are the parameters to be estimated ,the coefficient of interest is β_2 , while ε_i ε_i is the error assumed to be normally distributed. The relationship between the, MPI and explanatory variables is defined in Table 3.3.

Table 3.3: Definition and measurement of variables used in the models

Variables	Definition	Expected sign
Independent Variables:		
Household characteristics		**MPI**
Age	Number of years of the household head	+/-
Household size	Number of persons in the family	+/-
Sex	If male=1 female =0	+/-
Years of education	Number of years household head have spent in formal education	–
Wealth indicators		
Area cultivated	Total farm cultivated in hectares	-
Crop diversification	Number of crops cultivated	-
Social network and institutional characteristics		
Membership of commodity association	If household is a member =1. Not member 0	-
Number of extension visit	Number of extension visits per month	-
off-farm income	Total off-farm income	-
Market participation	Extent of market participation	-
Crop diversification	Number of crops cultivated	+
Village characteristics		
Distance to market	Distance to rural market in kilometers	+

3.4 Results and Discussion

3.4.1 Descriptive analysis of the welfare outcomes based on GESS participation status

Table 3.4 presents the summary statistics of the income variables based on participation status. We found that the percentage share of maize in total value of crop production of was 42.8% and 35.8% for GESS participants and non-participants respectively, and the

difference was statistically significant. The value of maize is the income generated from sell of maize plus imputed value of own consumption. Maize hybrid is the main food crop that is supported under the GESS subsidy programme, however the findings suggests that farmers are likely to move away from maize monoculture cropping system. The results further show that the share of farm income in total household income of participating households and non-participants was 71.3% and 64.8% respectively. The findings agrees with (Adenegan *et al*., 2018) who found that GESS initiative impacted on the farm income of maize farmers in Oyo State, indicating that productivity-enhancing agricultural innovations can contribute to raising the income of farming households, improve poverty alleviation and food security in Nigeria. This reflects the fact that agriculture remains the key employer of labour in the economic portfolio of rural households. This is in contrast with (Djido and Shiferaw, 2018) who found that rural households in Nigeria earn more income from off farm activities than farm sources. Therefore efforts to promote agriculture will have serious implication for farmers' income and poverty reduction. While we observed significant difference in farm income between the two groups, they did not differ in non-farm income. This result could be true for a number of reasons, (i) It could be that most farmers are unable to diversify their income and so rely on farming. (ii) It could also be a reflection of the impact of GESS subsidy programme in encouraging farmers to invest in agriculture. (iii) Receiving subsidized inputs may encourage on farm work which could potentially crowd out off -farm activities. The results further show that the mean income per capita of the sampled population was about #26, 497. The mean difference in income per capita between GESS participants and non-participants was #4444 and statistically at $p \leq 0.05$ representing 15.3% difference in per capita income between the two groups.

Table 3.4: Estimation of household income of the sampled population

Variable	Full sample	GESS participants	Non-participant	Mean diff
Value of Maize produced	134 900 (37 000)	150 350 (78 900)	122 900 (68 400)	27497**
Value of other crops	187 700. (101 230)	200 367 (129 000)	220 000 (104 500)	19633**
Net value of crop production	332 600	351 017	342 900	8117
Net Value of livestock production	20 890. (3500)	34500 (6500)	31 750 (7900)	2750
Net farm value of production	343 491 (109 800)	385 218 (137 800)	371 651 (189 000)	13566**
Cost of fertilizer	9700 (1200)	10 734 (5600)	19 690 (6780)	-8956*
Cost of pesticides	35 000 (3000)	4000 (1900)	4500 (1000)	500
Cost of transportation	5480 (2900)	6500 (3560)	6800 (3450)	300
Cost of labour of all farm operations	63 000 (23 900)	52 000 (34 900)	51000 (26 790)	1000
Total cost of production	82 080	69 345	81 990	-126145**
Total net farm income	261 310 (97 000)	315 873 (19 569)	289 661 (180 900)	26211**
Non-farm farm income	180189 (109 000)	126 919 (69 000)	144 780 (97 000)	8449
Total household income	441 500 (235 600)	442 792 (198 670)	446 442 (230 000)	3650**
Income per capita	36 791 (9000)	26 780 (24 000)	22 341 (13 000)	4679*

Significant at 10%, 5%, and 1% level, respectively. *Notes*: Numbers in parentheses are standard deviations. All values are in Nigerian Naira (#), 1USD= #360.00 as at 2017 exchange rate.

In order to capture the non-monetary dimensions that constitute poverty, we estimated the MPI based on Alkire-Foster (AF) method. Table 3.2 presents the estimated Multidimensional Poverty indices comprising of Multidimensional Poverty head count (H), mean intensity of poverty (A) and Multidimensional poverty index (MPI). Based on the threshold of the AF method, a household is considered deprived in each of the indicators if the weighted deprivations fall below the threshold ($K = 0.33$). The study identified households to be MPI poor if the household total deprivation score is greater than or equals to one third of weighted deprivations.

From Table 3.5, results show that on average the Multidimensional poverty head count of the sampled households was 64%, meaning that 64% of the population is MPI poor. This has serious implication for the attainment of sustainable development goals of ending poverty by the year 2030. This is not surprising because OPHI, (2019) puts the multidimensional poverty head count of rural Nigeria at 66%.The multidimensional poverty head count of non- participants (69%) was statistically higher than GESS participants (59%) meaning that non-participants suffer more deprivations .The results in Table 3.2 further show that MPI mean intensity across all households is 0.49 indicating that on average the MPI poor in the sample are deprived in 49% of the weighted indicators. Although non-participants were more deprived, looking at MPI mean intensity of GESS participants (0.45) and non-participants (0.47), we found no statistically significant difference between the two groups at $K=3$. We also found that the MPI score of sampled population was 0.32 which lies slightly below the cut-off point of 0.33. It implies that on average, 32% of the households suffer from multiple deprivations; this is higher than the mean of 0.31 for Nigeria but lower than the mean of 0.40 for Kano State (OPHI, 2019).While the MPI of GESS participants was found to be 0.29 on average. However, the difference in MPI between the two groups was -0.07 and statistically significant at $P\leq 0.1$, suggesting a weak impact of GESS on MPI. However, we did not check the sensitivity of the MPI value at different poverty cut off, although few studies have reported that MPI decreases with increase in poverty cut off (Wang and Wang, 2016; Delacic *et al*., 2017).

Table 3.5: Descriptive statistics of the respondents by MPI head count, MPI intensity and MPI

	Full sample	Participants Mean	Standard deviation	Non-participants Mean	Standard deviation	Mean diff
Multidimensional Headcount ratio (H)	0.64	0.59	0.29	0.69	0.43	-0.17**
MPI intensity (A)	0.49	0.45	0.34	0.47	0.31	-0.04
MPI (Adjusted head count ratio (Mo)	0.32	0.29	0.17	0.32	0.22	-0.07*

Computed from household survey, 2017. Note: *, **, *** indicate significance at 10%, 5% and 1%.

3.4.2 Relationship between household income and multidimensional poverty index

In order to examine the impact of GESS programme on multidimensional poverty index of smallholder maize farmers in Kano, we assumed that the impacts of GESS on multidimensional poverty are primarily channeled through the income pathway. Hence, we began by checking the association between household income and poverty status. We categorized household income into three income terciles: low, medium and high. We perform a cross-tabulation to observe association between income per capita and MPI status which cannot be observed within the data. The result is presented in Table 3.6 where we found a statistically significant association between income terciles and MPI status (Chi-square 53.2 $P \leq 0.000$). The Cramer V value of 0.3664 further also confirms that there is a strong association between income level and poverty status of the households'. Specifically, the result shows that 55.56% of households who are not MPI poor were found in the high income category compared to 20.83% of the households in the low income category. While 19.92 % of the household who are identified to be MPI poor were found in the high income category compared to 46.65 % in the low income category. This suggest that 46.65% of the sampled population is found in the low income

category. The probability that an MPI non- poor household will be found in the high income category is 2.6 times more likely than 0.42 times for an MPI poor household. The results suggest that poverty decreases when household income increases, implying that the current GESS programme is effective in raising farmers' income, however, whether the income is used to improve health care services, education or household asset which improves the quality of life cannot be explained by income measure alone.

Table 3.6: Relationship MPI status and income category

Farmer characteristic	**Income category**			**Total**	**Significance of chi-square (p)**
	Low	**Medium**	**High**		
MPI non- poor	20.83	23.61	55.56	100	0.000
MPI Poor	46.65	19.43	19.92	100	
likelihood-ratio					0.000
chi2(2)					0.3664
Cramer's V					

We further examined the contribution of MPI dimensions and indicators to the MPI and the result is presented in Appendix 3.6.We found that households were more deprived in living standard and deprivation was statistically higher among non-participants than GESS participants. Moreover on average, (60%) of the households in the total sampled were deprived in electricity. We also found high deprivations in sanitation, housing conditions, cooking fuel, asset ownership and food availability. Poverty indicators such as cooking fuel and asset ownership can be improved when farmers' income is improved, other indicators such as access to electricity, and safe drinking water may require broader infrastructural investment that is beyond the scope of individual households. The challenge of electricity supply calls for the need on the part of government and all stakeholders to step up action at rural electrification. While sanitation can be reduced by

using existing by-laws coupled with effective methods of raising awareness on environmental sanitation edicts and regulations.

3.4.3 Impact of GESS subsidy on multidimensional poverty: Results from PSM

The result from the impact of GESS subsidy on MPI using PSM is presented in Table 3.7. The result is the average treatment effect on the treated (ATT) which is estimated by averaging within-match differences in multidimensional poverty index of GESS participants and non-participants. The result showed that the impact of GESS on MPI is in the range of -0.05 to -0.06 representing 15.6 % to 19.4% decrease in total deprivations among GESS participants depending on matching method .The results suggest that GESS has reduces multidimensional poverty. The result is in line with Song and Imai (2019) who found that MPI decrease within a range of 0.04 to 0.05 in the Kenyan's Hunger Safety Net programme.

Table 3.7: Average treatment effect: Propensity score matching

Outcome variables	Matching Algorithm	Mean of outcome variables based on matched observations		ATT	
		GESS participants	Non-participants		% difference
Multidimensional poverty index(MPI)	NNM	0.32	0.38	-0.06**	-18.8
	KBM	0.31	0.37	-0.06**	-19.4
	RCM	0.32	0.37	-0.05**	-15.6

NNM=Nearest Neighbour Matching, KBM=Kernel Band Matching, RCM=Radius Caliper Matching *,**,*** significant at 10%,5% and 1%.

3.4.4 Impact of GESS subsidy on multidimensional poverty index: Results from Logit regression with instrumental variable

The econometric result of the impact of GESS programme on multidimensional poverty index and its influencing factors is presented in Table 3.8. Logistic regression was employed to predict the probability of a household being MPI poor and those factors affecting MPI. The model had good fit and most variables performed as expected

$13{,}390(39.10, P<0.000)$ $F¿$ ¿. The results shows that the coefficient of GESS participation (-0.168) is statistically significant at $p\leq 0.05$. This means that GESS subsidy programme is likely to reduced households acute deprivation by 16.8 percentage points holding other factors constant.

The results also show that, an additional year of schooling is more likely to reduce households' acute deprivation by 16.7 percentage point holding other factors unchanged. The coefficient of off farm income (-0.225) was negative and highly significant, suggesting that off –farm income is likely to reduce the probability of household to be MPI poor by 22.5 percentage points holding other factors constant. In line with our findings (Adeoye *et al.,* 2019) also found that off-farm income components significantly reduce acute deprivations of farm households in western Nigeria. This is as expected because off-farm enterprises offer a potential escape route from poverty as growth in agricultural sector can induce growth in the off-farm sector.

The coefficient of crop diversification which is measured by the number of crops grown within the year was found to significantly affect MPI. Farmers diversify their production portfolio to smoothen their income and to protect against consumption risk. Therefore linking farmers with markets plays an essential role in assuring better income for smallholder farmers, and thus contributing to poverty alleviation (Odhiambo Ochola and Fengying, 2015).

The coefficient of household size is negatively correlated with MPI indicating that larger households are likely to reduce the MPI holding other factors constant. The reason is that in a labour intensive economy, households with large family size tend to engage more farm and off-farm for agricultural and non- agricultural wage income respectively, thus

income realized can be reinvested to self-finance the purchase of farm inputs or finance household consumption of goods and services.

Table 3.8: Impact of GESS on multidimensional poverty index

Variable	Logit		Marginal effect	
MPI(Dummy)	Coefficient	Standard error	dy/dx	Standard error
Independent variables :				
GESS participants	-0.168**	0.034	-0.185**	0.066
Age of Household head	-0.022*	0.013	-0.001*	0.003
Household size(AE)	-0.066**	0.037	-0.010 **	0.008
Sex of household head	-0.326	0.312	-0.029	0.011
Area_ cultivated	0.060	0.050	0.047	0.040
Years of education	-0.109***	0.033	-0.260	0.008
Number of extension visits	0.154	0.140	0.009 .	0.031
Access to credit	0.178***	0.032	0.106**	0.079
off farm income	-0.225***	0.110	-0.190***	0.465
Market participation	0.011	0.008	-0.009	0.001
Crop diversification	-0.409**	0.156	-0.089	0.043
Distance to _market	0.081**	0.043	0.027 **	0.010
Membership of Comm_assoc.	-0.011	0.012	-0.018	0.018
Mean dependent var	0.631	SDdependent var	0.483	
Pseudo R-squared	0.176	Number of obs	390.000	
Chi-square	39.104	Prob > chi2	0.000	

**** p<.01, ** p<.05, * p<.1*

3.4.5 Relationship between income variables and MPI indices

We examined the relationship between income variables and MPI indices to understand the impact mechanism and the result is presented in Appendix 3.6. Interestingly, we found a statistically significant effect of income variables on MPI and MPI intensity but the effect of farm income was more on multidimensional poverty head count. Specifically a percentage increase in farm income is likely to decrease the probability of a household being MPI poor by 28 $\left(e^{-0.24}-1\right)X\,100$ point. Similarly, the findings on Appendix 3.7 indicates that an increased in farm income decreases multidimensional poverty head count by 14 $\left(e^{-0.12}\right)X\,100$ and MPI intensity by 20.2%. These findings indicate that improving farmers productivity has significant implication for household income and poverty

reduction. However, our findings is in contrast with (Kato, 2016; Gine *et al*., 2019) who found that input subsidy programmes did not result in improvement in agricultural productivity and welfare in Tanzania and that investments should be directed to other aspects of agriculture such as soil quality and irrigation. However, looking at our results, we have sufficient evidence to conclude that GESS subsidy decrease multiple deprivations among GESS participants. Therefore the analysis of poverty should be multidimensional rather than focusing on economic deprivations. Overall, our findings supports the view that 30% of poverty reduction among rural farmers in SSA is attributed to poverty alleviation programmes (Barrientos, 2016).

3.5 Summary, Conclusions and Recommendations

The study analyzed the impact of GESS subsidy programme on household welfare of smallholder maize farmers in Kano state. The study used Alkire-Foster MPI method which captures 3 dimensions of poverty; education, health and living condition each with various indicators to measure the welfare impact of GESS. As an analytical approach, the study employed propensity score matching that controls for selection bias and binary logistic model with instrumental variable method which controls for potential endogeneity were used to estimate the impact of GESS on multidimensional poverty index. First, the results from descriptive statistics shows that the multidimensional head count of participating households on average was 0.59, while th mean MPI intensity was 0.45 and the MPI was found to be 0.29. In addition we found that electricity, drinking water, asset ownership and cooking gas contributed most to household deprivation than other indicators and households were more deprived in electricity supply (60%). The result from cross-tabulation shows a statistically significant association between MPI status and income level. The results indicate that farmers' poverty level decreases with increase in household income. While the findings from PSM show that GESS significant decreased

MPI within the range of 0.05 to 0.06 depending on matching method .While the results from binary logistic model with IV method indicates that GESS participants are 15.6 to 18.8% less likely to be MPI poor. The results were robust with different analytical methods. Further examination of the impact pathway shows a negative and statistically significant correlation between income variables and MPI indices but the effect of farm income was more. This underscores the need to address food insecurity and poverty reduction through enhancing smallholder productivity. Consistent with the theory of change, increase in farm productivity would results in increase in farmers' income and thus their ability to self -finance the purchase of costly inputs as well as increase expenditure on goods and services at household level (Dorward *et al*., 2008). We also found that off farm income, market participation, age of household head, education level and membership of commodity association decreased the probability of a household to be MPI poor. Therefore, these factors ought to be accorded priority in designing poverty reduction programmes in the future.

An important policy implication of the finding is that public expenditure on provision of portable water, education and road infrastructure is key to improving rural life. In addition, the government of Kano state and other stakeholders should step up effort at rural electrification. We recommend further research that will inform the development of policies and programmes that will promote the growth rural of non-farm employment. Finally, while education is important, further research is also needed on the right education that can help farmers to improve rural livelihoods.

References

Aboaba, K. O., Adenle, S. M., Sowunmi, E. O. and Akinade, A. I. (2019). Nexus between Poverty and Livelihood Diversification among Rural Households in Nigeria: A Multidimensional Poverty Index Approach. *International Journal of Advantage Research and Publication* 3(5): 168-175.

Adenegan, K. O., Adenegan, F., Fagbemi, O. and Osanyinlusi, I. (2018). Impact of the 'Growth enhancement support scheme (GESS)' on farmers' income in Oyo state, Nigeria. *The Journal of Developing Areas* 52(1): 14-28.

Adenuga, A. H., Omotesho, O. A., Ojehomon, V. E. T., Diagne, A., Ayinde, O. E. and Arouna, A. (2016). Adoption of Improved Rice Varieties and its Impact on Multi-Dimensional Poverty of Rice Farming Households in Nigeria. [https:// www.researchgate.net/publication/309780992] site visited on 12 August 2018.

Adeoye, I. D., Seini, W., Sarpong, D. and Amegashie, D. (2019). Effect of off-farm income on multi-dimensional poverty among rural farm households in Nigeria. *International Journal of Social Economics* 2(2): 15-33.

Ahmed, F., Yusuf, A. and Dunah, F. (2016). Effect of growth enhancement support scheme (GESS) on the food security status of Rural Farming Households in Adamawa State, Nigeria. *EPRA International Journal of Economics and Business Review Economic* 2016: 1–19.

Ahmed,M.H.,Geleta,K. M.,Tazeze ,A and Andualem, E .(2017).The impact of improved maize varieties on farm productivity and wellbeing .Evidence from East Hararghe Zone of Ethiopia ,*Development Studies Research* 4:9-21.

Alkire, S and Roche, J. M. (2012). Beyond headcount: The Alkire-Foster approach to multidimensional child poverty measurement. *Child poverty and inequality: New perspectives*. pp. 18-22.

Alkire, S. and Foster, J. E. (2011). Counting and multidimensional poverty measurement. *Journal of Public Economics* 95(7-8): 476–487.

Alkire, S. and Santos, M. E. (2014). Measuring acute poverty in the developing world: Robustness and scope of the multidimensional poverty index. *World Development* 59: 251-274.

Alkire, S. and Seth, S. (2015). Multidimensional poverty reduction in India between 1999 and 2006: Where and how?. *World Development* 72: 93-108.

Awotide, B. A., Awoyemi, T. T., Omonona, B. T. and Diagne, A. (2016). Impact of Improved Agricultural Technology Adoption on Sustainable Rice Productivity and Rural Farmers' Welfare in Nigeria. *Inclusive Growth in Africa: Policies, Practice, and Lessons Learnt.* pp. 216-237.

Ayinde, O. E., Olaoye, I. J., Bolaji, M. O and Oloyede, A. O. (2019). Politics in fertilizer subsidy implementation and governance structure towards agricultural and economic Development in Nigeria: a review. Invited paper presented at the 6th African Conference of Agricultural Economists, September 23-26, 2019, Abuja, Nigeria.

Barrientos, A. (2016). Justice-based social assistance. *Global Social Policy* 16(2): 151 – 165.

Burchi, F., Rippin, N. and Montenegro Munoz, C. (2018). From income poverty to multidimensional poverty: A international comparison. *International policy centre for inclusive Growth, Working paper.* 174pp.

Caliendo, M. and Kopeinig, S. (2005). Some particular guidance for the implementation of propensity score matching. *Discussion Paper Series, 1588*.

Carroll, R. J., Ruppert, D. and Stefanski, L. A. (1995). Instrumental Variables. In: *Measurement Error in Nonlinear Models*. Springer US. pp. 107-121.

Chirwa, E. and Dorward, A. (2013) *Agricultural Input Subsidies:The Recent Malawi Experience*, Oxford: Oxford University Press. 320pp.

Claro, R. H., Levy, R. B., Bandoni, D. H. and Mondoni, L. (2010). Per capita versus adult equivalent estimates of Calorie availability in Household budget surveys. *Caderos Saude Publica* 26(11): 2188-2195

Delalić, A., Somun-Kapetanović, R. and Resić, E. (2017). New Multidimensional Approaches to Poverty Measurement in Bosnia and Herzegovina. *Croatian Review of Economic, Business and Social Statistics* 3(1): 1-15.

Djido, A. I. and Shiferaw, B. A. (2018). Patterns of Labour Productivity and Income Diversification: An Empirical Evidence from Uganda and Nigeria. *World Development* 105: 416-427.

Dorward, A., Roberts, P. D., Finegold, C., Hemming, D. J., Chirwa, E., Wright, H., Hill, R. K., Osborn, J., Lamontagne-Godwin, J., Harman, L. and Parr, M. J. (2014). Protocol: Agricultural Input Subsidies for improving Productivity, Farm Income, Consumer Welfare and Wider Growth in Low- and Middle-Income Countries: A Systematic Review. The Campbell Collaboration. [https://www.cabi.org/Uploads/CABI/about-us/Scientists%20output/Farmer-outcomes.pdf] site visited on 12 May, 2019.

FMARD (2014). *Agricultural Transformation Agenda: We Will Grow Nigeria's Agricultural Sector, Draft, Abuja, Nigeria*. Computer Disk, Washington DC. 135pp.

Gine, X., Patel, S. Ribeiro, B. and Valley, I. (2019). Targeting Inputs: Experimental Evidence of Tanzania. Policy Research Working Paper 9013 Washington, DC: World Bank Group. 45pp.

Guo, S. and Fraser, M. W. (2015). Propensity score matching and related models. *Guo SY, Fraser MW. Propensity score analysis: statistical methods and applications, 2nd ed. Thousand Oaks: Sage Publications*. pp. 129-202.

Hemming, D. J., Chirwa, E. W. Dorward, A., Ruffhead, H. J., Hill, R., Osborn, J., Langer, L., Harman, L., Asaoka, H., Coffey, C. and Phillips, D. (2018). Agricultural Input Subsidies for Improving Productivity, Farm Income, Consumer Welfare and Wider Growth in Low and Lower Middle Income Countries: A Systematic Review'. *Campbell Systematic Review* 14(1): 1–153. https://doi.org/ 10.4073/ csr.2018.4.

Imbens, G. W. and Wooldridge, J. M. (2009). Recent developments in the econometrics of program evaluation. *Journal of Economic Literature* 47(1): 5-86.

Isinika, A., Mlay, G., Boniface, G., Mdoe, N., Poulton, C. and Saha, A. (2020). *Does Rice Commercialisation Impact on Livelihood? Experience from Mngeta in Kilombero District, Tanzania*, APRA Working Paper 30, Brighton: Future Agricultures.

Jayne, T. S., Mather, D., Mason, N. and Ricker-Gilbert, J. (2013). How do Fertilizer Subsidy Programs Affect Total Fertilizer Use in Sub-Saharan Africa? Crowding Out, Diversion and Benefit/Cost Assessments. *Agricultural Economics* 44(6): 687–703.

Kato, T. (2016). *Agricultural Input Subsidies in sub-Saharan Africa – The Case of Tanzania.* PhD thesis for Award Degree of Doctorate at Brighton: University of Sussex. Available at: [http://sro.sussex.ac.uk/id/eprint/64928] site visited on 22 October, 2020.

Kovacevic, M. and Calderón, M. C. (2014). UNDP's multidimensional poverty index: 2014 specifications. *UNDP Human Development Report Office Occasional Paper*.

Liverpool-Tasie, L. S. O. and Takeshima, H. (2013). Input Promotion Within a Complex Subsector: Fertilizer in Nigeria. *Agricultural Economics* 44: 581–94.

Lunduka, R., Ricker-Gilbert, J. AND Fisher, M. (2013). What are the farm-level impacts of Malawi's farm input subsidy program? A critical review. *Agricultural Economics* 44(6): 563-579.

Mason, N. M. and Tembo, S. T. (2014). *Do input subsidies reduce poverty among smallholder farm households? Evidence from Zambia* Agricultural and Applied Economics Association (AAEA) 2014 Annual Meeting, July 27-29, 2014, Minneapolis, Minnesota.

Meemken, E. M., Spielman, D. and Qaim, M. (2017). Trading off nutrition and education? A panel data analysis of the dissimilar welfare effects of Organic and Fairtrade standards. *Food Policy* 71: 74-85.

Odhiambo Odhiambo Ochola, R. and Fengying, N. (2015). Evaluating the effects of fertilizer subsidy programmes on vulnerable farmers in Kenya. *Journal of Agricultural Extension and Rural Development* 7: 192-201.

Ogutu, S. O. and Qaim, M. (2018). Commercialization of the small farm sector and multidimensional poverty. Global Food Discussion Paper 117, University of Goettingen. [ttp://www.unigoettingen.de/de/213486.html] site visited on 15 September 2017.

Okoh, S. O., Okwuokenye, G. F. and Urhibo, F. A. (2018). Assessment of Growth Enhancement Support Scheme: Paradigm shift for poverty alleviation and increased farm income among farmers' in Delta state, Nigeria. *European Journal of Physical and Agricultural Sciences* 3: 1-12.

Olomola, A. S. (2015). Driving agricultural transformation with the power of information and communication technology: The performance of Nigeria's Growth Enhancement Support Scheme, NSSP Working Paper 30. Washington, DC: International Food Policy Research Institute.

Oluwafemi, Z. O., Amao, S. A., Adeagbo, T. A., Ogunsola, T. O. and Otun, L. O. (2016). Economic Effect of Growth Enhancement Scheme (GESS) On Ofada Rice Production in Obafemi Owode Local Government Area, Ogun State. *European Academic Research* 3(12): 12926-12937.

OPHI (2018). *Kenya Country Briefing.* Multidimensional Poverty Index Data Bank, Oxford Poverty and Human Development Initiative, University of Oxford. 18pp.

OPHI (2019). Nigeria Country Briefing", Multidimensional Poverty Index Data Bank. Oxford Poverty and Human Development Initiative, University of Oxford. Available at: [www.ophi. org.uk/multidimensional-poverty-index/mpi-country-briefings/] site visited on 10/08/2018.

Ricker-Gilbert, J., Jayne, T. S. and Chirwa, E. (2011). Subsidies and crowding out: A double-hurdle model of fertilizer demand in Malawi. *American Journal of Agricultural Economics* 93(1): 26-42.

Shively, G. E. and Ricker-Gilbert, J. (2013). Measuring the impacts of agricultural input subsidies in Sub-Saharan Africa: Evidence from Malawi's farm input subsidy program. *Purdue Policy Research Institute (PPRI) Policy Briefs* 1(1): 1-4.

Song, S. and Imai, K. S. (2019). Does the Hunger Safety Net Programme reduce Multidimensional poverty? Evidence from Kenya. *Development Studies Research* 6(1): 47-61. DOI: 10.1080/21665095.2019.158234.

Storck, H., Emana, B., Adnew, B., Borowiccki, A. and Woldehawariat, S. (1991). FarmingSystems and Resource Economics in the Tropics: Farming System and Farm Management Practices of Smallholders in the Hararghe Highland. Vol. II. Kiel: Wissenschaftsverlag Vauk

Wang, Y. and Wang, B. (2016). Multidimensional poverty measure and analysis: a case study from Hechi City, China. *Springer Plus* 5(1): 642-658.

Wooldridge, J. M. (2010). *Econometric Analysis of Cross Section and Panel Data*. The MIT Press. 97pp.

Wossen, T., Abdoulaye, T., Alene, A., Feleke, S., Ricker-Gilbert, J., Manyong, V. and Awotide, B. A. (2017). Productivity and welfare effects of Nigeria's e-voucher-based input subsidy program. *World Development* 97: 251–265.

CHAPTER FOUR

4.0 Impact of Growth Enhancement Support Scheme on Income Distribution of Smallholder Maize Farmers in Kano State: An IV-QTE approach.

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Abstract

Most studies on the impact evaluation of farm input subsidy programmes focused on average treatment effects, but the distribution of the outcome variables may change in many ways that cannot be revealed by an examination of mean effect. In an attempt to go beyond the average treatment effect, this paper examined the distributional impact of Growth Enhancement Support Scheme on the household income of smallholder maize farmers in Kano, Nigeria. A two stage sampling design with stratification was used to collect cross- sectional household survey data from 390 randomly selected smallholder maize for the analysis. The study employed a conditional Instrumental Variable Quantile Treatment Effect (IV-QTE) approach which controls for selection bias that may arise from both observed and unobserved factors when assignment into treatment is non-randomized. Based on the results of (IV-QTE) model, we found that GESS subsidy is heterogeneously across distribution of income. Specifically, GESS raise income for farmers along lower

half (lower quantiles) of the income distribution than at the upper half (median and above) and the fraction of the poor who received more benefits from the programme vary by age, years of education, market participation and area cultivated Thus, GESS decreased inequality and therefore GESS was pro-poor in income. The result is in line with the government objective of assisting poor farmers to increase their productivity and income. The study recommends the need to improve GESS design and implementation process, so that by reaching the poorest and vulnerable farmers with fewer resources, the programme will increase its benefits to the poor. The result is the wish of the government as the objective of the scheme is to assist poorer farmers to increase productivity and income. The study recommends that improving GESS targeting and implementation process to reach the poorest and vulnerable farmers with fewer resources will increase programme benefit to the poor.

4.1 Background to the Study

Progress in the agriculture sector is seen as vital for sustainable pro-poor economic development, food security and poverty alleviation (Asfaw *et al*., 2012). African agricultural performance is disappointing and its growth is lagging behind population growth (Ahmed *et al*., 2017) which affects the poor who heavily depends on the income derived from farming. Although the agricultural sector boast of high employment rate. Most of the poor households who depend on it for livelihood lack the resources and knowledge needed to benefit from new technologies or access to markets, which would increase farmers' productivity and income (FAO, 2018). (Liverpool-Tasie, 2013) argued that Nigerian farmers finds it very difficult to access quality agricultural inputs, such as seeds, pesticides, fertilizer and credit needed to scale up their operations.

In Nigeria, different policies and programmes introduced by different administration have shown commitment to finding solution to low agricultural productivity in the country .For

example, in 2011; the Nigerian government introduced the Growth Enhancement Support Scheme (GESS) with the aim of improving farmers' access to modern agricultural inputs at subsidized prices, hence guarantying food security and increase in farmers' income. The GESS programme targeted smallholder farmers with fertilizers and improved maize seeds through mobile phone technology. In recent time ,the use of mobile phone technology have been more effective in reaching farmers directly with subsidized farm inputs and is less likely to distort the market than methods that were used in the past, such as direct subsidies and centralized control of fertilizer procurement and distribution (Wiggins and Brooks, 2010).

There is concern that GESS subsidy programme has continued to eat deep into the government treasury (Otekurin *et al*., 2019). For example, (Agboola and Agboola, 2015) cited by (Micheal *et al.,* 2018) found that the Nigerian public spending on fertilizer subsidies increased from #13.30 billion (USD84.44 million) in 2012 to #82.38 billion (USD519.57) in 2014 and in 2015 alone, #26Billion (USD 134million) was spend on the procurement and distribution of fertilizers to farmers across the country.

There is growing empirical evidence on the economic impacts of farm input subsidy in SSA where questions are often raised about the ability of farm subsidies to raise farmers' income (Mason *et al.,* 2014). Previous studies such as Ricker-Gilbert *et al*. (2014) for Malawi; Kassie *et al*. (2015) for Eastern Zambia), Lunduka *et al*. (2017) for south Eastern Zimbabwe Adenegan *et al.* (2018) and Abdoulaye *et al.* (2018) for rural Nigeria and Kassie *et al.* (2018) for Ethiopia ,found positive impacts of farm subsidies on households' income. While (Kassie *et al*., 2014) in Tanzania found positive impact of maize varieties on food security in Tanzania. However, these studies examined conditional mean effect, 95% of impact assessment studies have focused on overall mean impacts (Frölich and

Melly, 2010). Conditional mean impact assumes that programme impacts farmers in the same way. Unfortunately, the distribution of farmer's income may be higher at the upper tail than lower tail suggesting that programme may not benefit in the same way. This knowledge gap is important because the probability that the distribution an outcome variable may change in many ways that cannot be revealed by the examination of averages (Eboh *et al*., 2006). Based on programme design, we expect GESS to improve the income of poor farmers. However, leakages and mis-targeting may divert subsidies away from the intended beneficiaries. In such circumstances GESS may only improve the income of larger farmers albeit smaller farmers which cannot be revealed by the observation of mean impact**.** There is patchy and scanty evidence of the distributional impact of farm input subsidy programmes in SSA.

Reuben and Adams (2015) used Nigeria General Household Survey (GHS)-Panel Datasets of 2010/2011 and 2012/2013 to compare the distributional impact of Voucher Fertilizer Subsidy Scheme and GESS E-wallet subsidy on the basis of accessibility and quantity of fertilizer purchased. On the basis pro-poor indices and benefit incidence analysis, they found that while Voucher Fertilizer Subsidy Scheme seems to be more pro-poor than E-wallet Fertilizer Scheme on the basis of accessibility, none of them was pro poor when the analysis was done on the basis of quantity of fertilizer purchased. In a more recent study (Wossen *et al.,* 2017) used a nationally representative household survey data to examined the distributional impact GESS e-wallet on the basis of farm size and gender, based on linear regression framework, their results show no heterogeneity in the distribution of subsidy benefits with respect to farm size and gender of the household head. One major weakness associated with these studies is the problem of endogeneity which arises from the fact that access to GESS fertilizer subsidy scheme is either voluntary or some farmers are in a better position than others to have access to the scheme Thus, selection into the

scheme is the major source of endogeneity in these past studies. There is patchy and scanty evidence of the distributional impact of farm input subsidy programmes in SSA. Moreover to the best of our knowledge no study has examined the distributional impact of GESS on household income. This knowledge is important because it has implication for poverty reduction and overall household wellbeing.

Therefore the question been addressed by this study is what is the impact of GESS subsidy on the distribution of farmers income? In this paper, we aim to contribute to this methodological gap in the impact literature by evaluating the impact of GESS subsidy programme on the distribution of farmer's income by using Instrumental Variable Quantile Treatment Effect (IV-QTE). Quantile treatment effect has the ability to characterize the heterogeneous impact of the treatment across the outcomes distribution (Frolich and Melly, 2010). This analytical approach is able to isolates the causal impact of GESS subsidy along the distribution of the household income while controlling for selectivity and potential endogeneity arising from observable and unobservable factors.

This study is justified on the basis that understanding how treatment varies across the distribution of outcomes suggests how best to target programmes to maximize their impact on the recipients (Friedlander ad Robins, 1997; Manski, 2004; Ikudayisi *et al*., 2019). The model will also tell how a particular group of interest responded to programme. This study contributes to the literature on distributional impact of farm input subsidy the focusing on the distributional impact of GESS on farmer's income in Kano State. The paper is organized as follows; Section 4.2 presents the background of GESS while section 4.3 describes the research methodology and section 4.4 focuses on the descriptive statistics and econometric results and discusses the main findings and finally conclusions and recommendations are discussed in section 4.5.

4.2 Background of Fertilizer Subsidy in Nigeria

In Nigeria, fertilizer subsidy occupies a central role in the policy tool of the government and this explains why the government at all levels has been involved in the procurement, distribution and price determination of fertilizer at various times. Nigerian involvement in the fertilizer distribution system dates back to 1976 when it adopted a national fertilizer policy to ensure national self-sufficiency through local production of farm inputs. However, with the introduction of the Structural Adjustment Programme (SAP) between 1980 and 1990, such universal subsidies were greatly cut- back across the regions. In particular, as part of the SAP, the World Bank (WB) advised countries in SSA to phase out input subsidies on the premise that the private sector can provide it more efficiently through market-based mechanisms (Ricker-Gilbert, 2014; Chirwa and Dorward, 2013). However, in the late 1990s and early 2000s. Large-scale targeted input subsidies were re-introduced as a replacement of the old universal input subsidy programmes (Jayne and Rashid, 2013; Jayne *et al.,* 2013).

In 2011, the government of Nigeria decided to launch an electronic voucher scheme called the Growth Enhancement Support Scheme (GESS) in the 36 states of the federation including Abuja federal capita territory. GESS was implemented with the intention of improving the efficiency of input distribution to smallholders through mobile technology. The programme aimed at promoting the production of key crops in the country along agro- ecological zones; maize production in the North, Cocoa production in the West and cassava and oil palm in East (FMARD, 2014; Fadairo, 2015). GESS only targeted core farmers and the general programme eligibility criteria was that beneficiaries should be core farmers who are not less than 18 years and are resident in the village for not less than ten years, must not own more than 3 hectares of cultivated land area and should own

own a mobile phone (Fadairo, 2015; Olomola, 2015). A registered farmer is entitled to 50% subsidy on two 50-kg bags of fertilizer (NPK and urea) and a 90% subsidy on a 50-kg bag of improved maize seeds through an e-voucher. The e-voucher that the farmers receive via their mobile phone entitles them to buy fertilizer and improved seed from local agro-dealers at a subsidized price (50% of selling price). The GESS intended to reach 20 million farmers with subsidized fertilizer and seeds within five years (Federal Ministry of Agricultural and Rural Development (FMARD, 2014) but by 2012, 13 million farmers had registered for GESS.

4.3 Research Methodology

4.3.1 Description of the study area

The study was conducted in Kano State, Northwest, and Nigeria in 2017. Kano state is also located in the North-West Geo-political Zone of Nigeria between latitudes 130^0 N and 110^0 S and longitudes 80^0N and 100^0 E with a landmass of 20 760 km^2. It's the largest state in Nigeria with 44 local governments. According to 2006 population census Kano State has a population of 9 383 682 (Mohammed, 2017). The average annual rainfall is 700 mm with 35^0 C and 19^0 C as mean daily maximum and minimum temperatures respectively. The cultivated cropland is dominated by maize, sorghum, millet and cowpea, grown either as single or intercropped. The average annual maize productivity is between 1200kg/ha and 1800kg/ha. The land holding size ranges between 1 and 10 hectares, with an average of 2 hectares per household.

4.3.2 Sampling procedure and data collection

The study employed a two-stage random sampling with stratification to select villages and farming households from the study area. In the first stage, 30 village areas were selected with probability proportional to size from 245 villages and 10 sampled local governments, while in the second stage 170 GESS participants were randomly selected from a list of

1750 registered maize farmers like below, while 220 non-participants were selected randomly selected from a list of 2100 maize farmers from village extension office at the village level. The list of GESS participants and non-participants was collected from Kano Agricultural and Rural Development Agency (KNARDA). The household survey data was collected by enumerators from the sampled households using a semi structured questionnaire. Prior to the household survey, the semi-structured questionnaire was pretested. The semi structured questionnaire was carefully tested prior to the survey. A broad range of information on the farming households' socio-economic characteristics, crop production, expenditure on food and non-food items, farm income and off –farm income sources were collected from the survey was elicited from both groups. However, inability to maintain the same population size for each stratum in the second stage suggest that sampling size may not be probability proportional to size hence we acknowledge difficulties in selecting a truly representative sample (Table 1.1).

4.3.3 Measurement of household income

We aggregated household income from farm, off-farm and non-farm sources. Farm income was estimated from crop and livestock income. While non-farm income was calculated from remittances, gifts, pensions, profits from non-farm business enterprise, while the off farm sources includes wages income from sell of labour off farm.

Crop income

We estimated crop income by taking the quantities of all crops harvested (sold and unsold) and valued them at farm gate prices to reflect the opportunity cost of own consumption. Farmers were asked to specify all costs incurred in crop production of all crops during the season under consideration. The cost of crop production includes cost of fertilizer, cost of hired labour, cost of transportation, imputed value of family labour and cost of agrochemicals. We subtracted production cost from total value of production to get the net crop income given by equation 1

$$CI_i = \sum_{J=1}^{J} \left[P_{ij} Y_{ij} - \left(P_{ij} X_{ij} - CF_{ij} - CH_{ij} - CT_{ij} \right) \right] \quad \text{.....(1)}$$

CI_i = Net crop income of household ith, Y_{ij} = total output of crop j from household ith (quantity sold, consumed, in-kind payment for labour, gift to friends and relations), P_{ij} = farm gate price of crop j sold and unsold from household ith, $P_{ij}X_{ij}$ = market cost of input X used in the production of crop j from household ith, CF_{ij} = imputed cost of family labour for crop j from household i which was calculated as average off farm wage of labor in naira per day in the village, CH_{ij} = cost of hired labour calculated as market wage of labour for crop j from household ith in naira per day, CT_i = cost of transportation in naira per day for household ith

Livestock income:

We estimated livestock income as the value of live and slaughtered animals, and animal products (live animals, meat, poultry, milk and eggs) sold and unsold less cost of production. The production cost includes imputed labour cost and cost of veterinary services .The cost incurred in production may vary with production system; however the variation in production system was not taken into account.

The net value of livestock is given by equation 2

$$LI_i = ¿ \sum_{j=1}^{j} \left[(P_{ij} Q_{ij}) - (C_{ij} Q_{ij}) \right]$$ ………………………………………………………

(2)

$LI_i = ¿$ Net livestock income from household i^th^, P_{ij} = market price of livestock, product j from household i^th^, Q_{ij} = Quantity of livestock product j (meat, live animals, eggs, birds and milk) from household i^th^, $C_{ij} Q_{ij} = ¿$ Cost of producing j quantity of livestock product (cost of feeds, veterinary services, hired labour, equipment and, Management cost) from household i^th^

Net farm income:

We estimated net farm income as the sum of net crop income plus the sum of net livestock income as in equation by 3.

$$NFI = NCI_i + NLI_i$$

…………………………………………………………………… (3)

Off farm income:

GESS subsidy may have a potential effect on off farm activities .Off farm income gives a measure of whether or not GESS subsidy has any positive spillover effect that may encourage households to invest in other off farm activities. Ricker-Gilbert *et al*. (2011) found that households who sold their labor off farm experienced some small spillover benefit from the program in the form of higher agricultural wage rates in Malawi. Off farm income sources includes income earned from off farm agricultural labour and imputed cost of family labour. We estimated family labour as average cost of farm labour per adult per day in village.

Non-farm income

This includes non-agricultural wages such as self-employment, informal wage or salaried wage, profits from non- farm business enterprises, transfer payments, pensions, gifts received and remittances.

Total household income

The effect of GESS subsidy on total household income provides overall measure of programme impact on household welfare. We estimated total household income as the sum of Net farm income, off-farm income and non- farm income. We express total household income in per capita terms as given by equation 5

$THI = NFI + OFI$ …… (4)

$HIP_i = ¿ \frac{THI_i}{n_i}$ …… (5)

HIP_i = Household income per capita of i household, n_i = household size of ith household. Similar approach has been adopted by (Ricker-Gilbert and Jayne 2012) in examining the welfare impact of Malawian farm input subsidy programme on maize farmers.

4.3.4 Analytical procedure

Quantile treatment effect framework

In examining the impact of GESS subsidy on income distribution requires an estimation technique in a linear quantile regression framework (Angrist and Imbens 1996) as in equation 1.

$Q_i^{\tau} = X_i \beta^{\tau} + D_i \delta^{\tau} + \mu_i$ …… (1)

Where δ^{τ} represents the quantile treatment effect of GESS (D) on Q_i corresponding to τ^{th} quantile of household income, X_i is a vector of observed

variables that includes socio-demographic characteristics, village and farm level characteristics. ith farmer , β^{τ} is a vector of parameters of covariates to be estimated, $\delta^{\tau} is$ the parameter of interest to be estimated which represents the impact of GESS while μ_i is unmeasured disturbance term or error term.

QTE is based on selection on observables, since selection of participants was not randomized; GESS participants are likely to be systematically different from non-participants. Therefore, it is not trivial to assume selection on observables (Diagne *et al*., 2009). We suspect that GESS is potentially endogenous. Therefore, estimating the distributional impacts of GESS subsidy using equation (1) will lead to biased and inconsistent estimates of δ^{τ} and β^{τ} . In this study, we employed a conditional endogenous QTE model and used the instrumental variable quantile treatment effect estimator proposed by Abadie *et al.* (2002). The conditional instrumental variable quantile treatment effects approach controls for selection bias from both observed and unobserved characteristics and estimates causal effect for the subpopulation of compliers, i.e. the subpopulation whose treatment status depends on the value of the instrument (Angrist and Imbens, 1996).

The IV-QTE method requires the use of a binary instrumental variable which is selected on the basis that the instrument must be correlated with the GESS participation and uncorrelated with income. Previous studies, such as Abdoulaye *et al.* (2018), Shiferaw *et al*. (2014) and Olagunju *et al*. (2019) examined the impact of Drought Tolerant Maize Variety (DTMV) adoption on the distribution of productivity and welfare outcomes in Nigeria. The study used access to variety of information as an instrumental variable for DTMV adoption. Other distributional impact evaluation studies such as (Diagne *et al.*,

2009; Dontsop- Nguezet *et al*., 2011; Diagne *et al*., 2013; Alia *et al*., 2018) used awareness as an instrument to identify the impact of technology adoption on the distribution of total and per capita household expenditure of smallholder farmers in Benin republic. Farmers who were aware of improved agricultural technology were assumed to have access to improved technology. Gelo *et al*. (2013) also examined the distributional impact of joint forest management on welfare outcomes of households in Ethiopia and used the presence of Menja tribe in the village as an instrument. The presence of Menja people was assumed to partly determine participation in Joint Forest Management in Ethiopia but not affect welfare directly.

Following (Alia *et al*., 2018; Didier *et al*., 2013), this study used awareness as an instrument to identify the impact of GESS subsidy on the distribution of household income per capita of smallholder maize farm households in Kano State. We assumed that awareness of the programme partly determined participation in GESS subsidy programme but does not directly affect farmers' income. In this study, 92% of the farmers were aware of GESS programme suggesting that, awareness is a good instrument for GESS participation. To measure awareness, we used a binary variable in which a value of one was assigned if farmers were aware of GESS and zero if a farmer was not aware of GESS programme.

The estimation of the treatment effects involves two steps: first, the propensity score is estimated non-parametrically; secondly, equation (1) is estimated via weighted quantile regressions (equation 2). The weights correct for differences in the distribution of covariates between participants and non-participants, where estimated weights, denoted with hats, are constructed from estimated propensity scores.

The empirical specification of the quantile regression is given by equation 2

$$\left(\hat{\beta}_{IV}^{\tau}, \hat{\delta}_{IV}^{\tau}\right) = \arg\min_{\beta,\delta} \sum W_i^{AAI} \rho^{\tau}\left(Q_i - X_i \beta - D_i \delta\right) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

With the instrumental quantile weight;

$$W_i^{AAI} = 1 - \frac{D_i\left(1-Z_i\right)}{1-P_r\left(Z=1/X_i\right)} - \frac{\left(1-D_i\right)Z_i}{1-P_r\left(Z=1/X_i\right)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots$$

……………...(3)

To identify QTT (equation 2), we used the instrumental variable Z_i (awareness), where, $Z_i = 1$ if farmer was aware of GESS, $Z_i = 0$ if farmer is not aware of GESS, X_i represents conditional variables that determines awareness. Awareness about GESS Programme in the village is assumed to partly determine by participation in GESS programme, without affecting farmers income.

Given the probability $P_r\left(Z_i = 1/X_i\right)$ of awareness of GESS subsidy i.e. propensity scores which predict awareness are estimated as in equation 3. However, some of the weights can be negative while others are positive, following Abadie *et al*. (2002). We use non-parametric linear regression to estimate positive weights using equation 4

$$W_i^{AAI+} = E\left(W^{AAI} / Q_i, D_i, X_i\right) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots$$

(4)

We included a set of variables that captures the characteristics of farming household such as gender, age, household size in adult equivalent, years spent in school, farming experience, number of years of residence in village, membership of commodity associations as well as variables that capture the wealth such as farm assets of the household. Other covariates included are access to credit, distance to nearest market and

input redemption centres. These variables are included based on the assumption that they influence GESS participation and the outcome variables. For instance, the years of experience is used as a proxy for level of farming experience; while educational level captures the level of farming skills needed to take advantage of registration into GESS. Farmers' membership of commodity association measures the level of social capital or network of the farming households. Farmers tend to take advantage of their membership of organization to obtain labour, securing of credit and insurance against risk Wossen *et al*. (2015) to improve their improved income. The conditioning covariates used in the model are defined in Table 4.1.

Table 4.1: Definition of variables to be used in the model

	Type and definition	**Measurement**	**Expected sign**
Income per capita	Continuous	Naira/household	+
Gender	Dummy: sex of household head	1 if male ,0 female	-/+
Educational level	Continuous: years of schooling of household head	Total number of years of formal education	+
Farming experience	Continuous: Number of years of farming of household head	Total years of farming experience	+
Household size	Continuous: total household size	Household size in adult equivalent	+
Years of residence	Continuous : Number of years of residence in the village	Total years of residence of household head in the village	+/-
Access to credit	Dummy : if household have access to credit	1 if household access credit ,0 otherwise	+
Access to different sources of information	Dummy : if household have access to different information sources	1 if household head does, 0 if otherwise	-/+
Membership of commodity Association	Dummy: if household head is a member of any commodity association/cooperative	1 if household head does, 0 if otherwise	-/+
Value of farm assets	Continuous : value of productive assets purchased in the last one month	In naira	+
Household landholding	Continuous: Total land area owned by household	Hectares	+
Area cultivated	Continuous: total land area cultivated	Hectares	+
Access to electricity	Dummy : if household head have access to electricity	1 if yes ,0 otherwise	+
Distance to market	Continuous : total distance from home to nearest market	Kilometres	_

Distance to redemption Centre	Continuous: total distance from home to input redemption Centre.	Kilometres	-
GESS participation (instrumented)	Dummy: Awareness	1 if household is aware of GESS , 0 if otherwise	_

4.4 Results and Discussion

The descriptive statistics of all the variables of interest used in the study are presented in Table 4.2. The results show that total farm income on average was #261310.While the difference in farm income between GESS participants and non-participants was #26 211 (Appendix 4.1) and was statistically significant. The outcome indicator of interest is the per capita income. Based on the t-test of statistical significance, we found that on average, the per capita income of the sampled population was #27679. The mean per capita income of GESS participants was #26791 and was higher than the mean per capita income of #22 341 for non-participant and the difference was significant higher at $p \leq 0.05$. To a large extent, this indicates a positive correlation between GESS subsidy and income of the farmers. This increased in household income underscores two key points about agriculture in Kano. First, maize is largely cultivated for household consumption, and secondly, for the majority of smallholders, there is very limited diversification away from staple crop production. Over-reliance on maize production may make it difficult for smallholders to increase income from other high value crops, such as fruit, rice, pulses, and roots. In addition to the outcome variables, Table 5.2 also reports the descriptive statistics of other variables included in our estimated model. GESS participants and non-participants are statistically different with level of education which is measured by years of schooling, value of farm assets, access to credits, membership of commodity association, farm size measured by total area cultivated and awareness of GESS programme.

Table 4.2: Descriptive statistics of variables used in the analysis

Variables	Full sample	GESS participants	Non-participants	Difference	Significance t-value/ z-value
Income per capita	27 679	26 780	22 341	4679	2.59**
Sex of HH	0.82	0.84	0.83	0.01	0.78
HH_Edu level	13.2	13.6	12.9	0.7	2.6**
Age HH	45.9	45.8	45.2	0.06	0.40
Marital status	0.91	0.87	0.94	- 0.07	0.41
HH_Size(AE)	12.40	11.30	13.00	-1.70	0.67
Access to elect	0.30	0.36	0.34	0.02	0.37
Diff sources _inf	0.94	0.95	0.92	0.03	0.88
Access credit	0.67	0.73	0.63	0.10	1.98**
Membership_comm	0.78	0.89	0.68	0.21	2.66**
Extension visits per month	2.3	2.2	1.7	0.5	1.45
Total landholding	4.4	4.36	4.15	0.22	1.50
Area cultivated	3.4	3.58	3.41	0.17	1.76*
Value of farm assets	25 780	28 900	21 000	7900	3.00***
Distance to nearest market	3.2	3.3	3.8	0.05	1.70*
Years_ residence	28.6	29	20.4	9.4	3.77***
Awareness	0.82	0.92	0.52	0.20	3.2 ***

Note: *. **, *** significant at 10%, 5% and 1%

4.5 Impact of GESS Subsidy Programme on the Distribution of Income

The impact of GESS subsidy on the distribution of household income is presented in Table 4.3. The result shows that the impact of GESS subsidy varies across the distribution of income. The impact was higher at the lower quantiles (Q0.10 and Q0.25), while lower estimates of the impact at the upper quantiles (Q0.75 and Q0.90) of household income. However, the results revealed that GESS impact is significantly higher at the lowest quantile (Q0.10), with highest effect in second quantile (Q0.25) and with statistically in significant impact on the median (Q0.50) and upper quantiles (Q0.75 and Q0.90). (Fig. 4.1) confirms that the distributional impact exhibits a downward sloping curve suggesting that farming households at the lower tail of the income distribution benefited more from programme impact in relative terms, suggesting that poorer households are more likely to be net producers and will be better off with more subsidies.

Furthermore, holding other factors constant, a percentage increase in GESS subsidy would increase household income by 18% in the first quantile, 23% in the second quantile, 9.5% in the third quantile, 7.9% in the fourth quantile and 0.6% in the fifth quantile. These are the conditional weighted averages of the subgroup effects at quantile level.

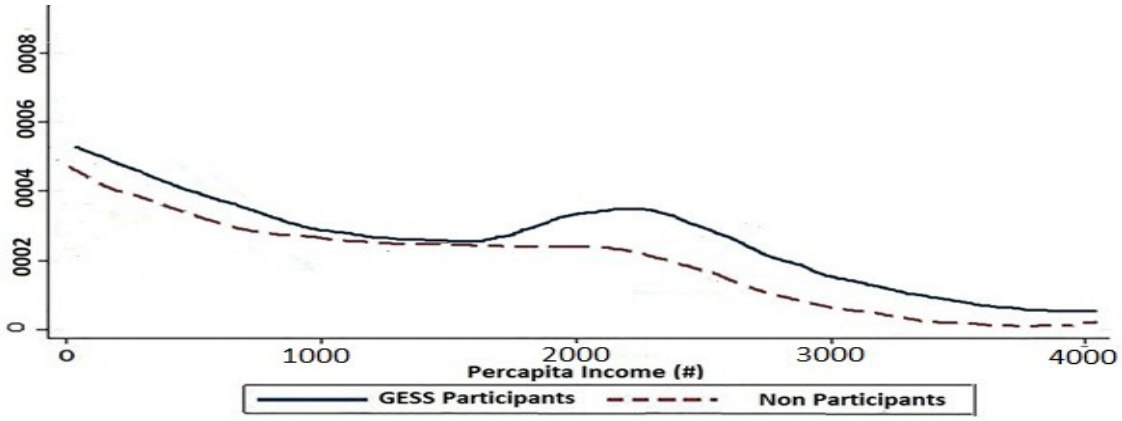

Figure 4.1: Kernel density of household income per capital by GESS participation

Conditioning on covariates, we also found that the treatment effect in the first quantile (0.10) is correlated with years of education and market participation (proportion of output sold). An additional year of education will increase household income by 2.6%, while growing additional crop increases household income at the lowest quantile by 2.6%. Furthermore, an increase in the proportion of output sold will increase household income in the first quantile by 4.7%. While in the second quantile, the age of the household head, area cultivated and a year of education are significant and positively correlate with household income. An additional year of the household head increases household income by 3.0% in the second quantile, while an additional area cultivated increases household income in the second quantile by 4.5%, meaning that the larger the farm**,** the higher the income support to the household. Furthermore, the positive effect of household size

indicates that family labour can result in increase in household income holding other factors unchanged. Furthermore, in the median income quantile (0.50), we found a positive and large effect of market participation which is measured by the proportion of output sold. An increase in the proportion of output sold will increase household income by 35.9%, this emphasize the need for policies and programmes that will link farmers with the market. While in the fifth quantile (0.90) we found that growing an additional crop will increase household income by 1.7%.

Overall, the finding indicates that farming households with lower income tend benefited more significantly from the GESS subsidy. Implying that, GESS decreased income inequality. The findings of this study agreed with those from other researchers for instance, Olagunju *et al*. (2019) found that farm households at the lower quantile of maize yield and per capita food expenditure benefited more significantly from the adoption of DTMVs in Nigeria. While Issahaku and Abdulai (2019) also found that farm households with lower food nutritional status benefited more from adopting climate smart practices in Northern Ghana .In another study Didier *et.al*.,2013) reported a large impact of NERICA rice adoption on the lower tail of the distribution of total household expenditure and per capita household expenditure in Benin republic. In contrast to our finding, Ricker-Gilbert and Jayne (2012) found that subsidized fertilizer increased crop income of households at the upper quantile with no significant effect on poor households at the lower crop income quantile in Malawi. Similarly, Gelo *et al*. (2013) used the same analytical approach in Ethiopia to examined the impact of Joint and found that Joint Forest Management i raise the welfare of households only on the upper half of the welfare distribution, they concluded that the programme was not pro-poor.

This analysis offers a clear picture of the differential impact of GESS subsidy on household income that is concealed in the conditional mean impact of GESS subsidy well documented in literature (Oguniyi *et al*., 2017; Wossen *et al.*, 2017; Adenegan *et al.*, 2018). This finding gives credence to GESS subsidy, which is aimed at bolstering the incomes of smallholder farmers. Furthermore, the result that GESS increases income of smallholder farmers in the lower income quantile is an indication that GESS is pro-poor. Therefore promoting GESS subsidy has the potential to raise farmers' income and reducing poverty.

Table 4.3: Distributional effects of GESS subsidy programme on household income based on conditional IV-QTE

Variables	Q0.10		Q0.25		Q0.50		Q0.75		Q0.90	
GESS_participation	0.185**	(0.095)	0.232**	(0.010)	0.095	(0.099)	0.079	(0.296)	0.006	(0.063)
Age of household head	0.010	(0.013)	0.030***	(0.010)	0.001	(0.003)	-0.000	(0.006)	0.012	(0.005)
Household size(AE)	-0.005	(0.056)	0.009**	(0.004)	-0.009	(0.033)	-0 .048	0.018	-0.008	(0.004)
Total area cultivated	0.066	(0.061	0.045**	(0.024)	0.008	(0.032)	-0.019	(0.072)	-0.003	(0.049)
Years of residence	-0.003	(0.013)	0.004	(0.007)	0.006**	(0.023)	0.001	(0.020)	0.000	(0.005)
Years of education	0.026 **	(0.010)	0.010**	(0.004)	0.002	(0.017)	-0.000	(0.009)	0.001	(0.008)
Years of experience	0.004	(0.009)	0.004	(0.007)	0.000	(0.004)	0.001	(0.018)	-0.000	(0.012)
Distance to farm	-0.010	(0.019)	-0.110**	(0.040)	0.003	(0.022)	0.100	(0.439)	0.003	(0.087)
Sex of household head	0.097	(0.301)	0.113	(0.247)	0.102	(0.320)	-0.061	(0.263)	-0.008	(0.097)
Access to credit	-0.079	(0.245)	0.117	(0.113)	0.039	(0 .089)	-0.065	(0.184)	-0.007	(0.052)
Membership of association	-0.003	(0 .395)	-0.257	(0.275)	-0.190	(0.292)	0.107	(0.273)	0.005	(0.134)
Access to electricity	0.191	(0.417)	-0.107	(0.327)	0.354	(0 .215)	-0.076	(0.417)	0.197	(0.112)
crop diversification	0.047**	(0 .024)	0.097	(0.245)	-0.076	(0 .223)	0.093	(0.279)	0.017 *	(0.009)
Market participation	0.417 *	(0.232)	0.032	(0.282)	0.359***	(0.170)	0.01289	(0.003)	0.110	(0.217)
Cons	10.734***	(0.083)	10.409 ***	(0.890)	10.745 ***	(1.001)	10.998***	(1.345)	11.110***	(0.374)
Number of observations	390		390		390		390		390	

Note: Numbers in parentheses are standard errors, *, **, *** indicates significance level at 10, 5 and 1%

4.6 Summary and Conclusion

This paper analyzed the impact of GESS subsidy programme on the distributions of farmer's income using the (IV- QTE) approach which controls for selection bias that may arise from observed and unobserved characteristics when treatment is not randomized. Our results confirmed that the impact of GESS was heterogeneous across the distribution of income. The impact was significantly higher for farmers in the lower tail of income distribution than the median and upper tail of the distribution. The findings suggest that GESS subsidy decreased income inequality therefore GESS is pro poor. Our findings provide an empirical support for the assumption that subsidy programmes are effective in increasing the income of smallholder farmers. The study recommended that improving targeting and implementation process will increase the benefits of GESS programme to the poor farmers.

References

Abadie, A., Angrist, J. and Imbens, G. (2002). Instrumental variables estimate of the effect of subsidized training on the quantiles of trainee earnings. *Econometrica* 70(1): 91-117.

Abdoulaye, T., Wossen, T. and Awotide, B. (2018). Impacts of improved maize varieties in Nigeria: Ex-post assessment of productivity and welfare outcomes. *Food Security* 10: 369–379.

Adenegan, K. O., Fagbemi, F., Osanyinlusi, O. I. and Omotayo, A. O. (2018). Impact of the Growth Enhancement Support Scheme (GESS)'On Farmers' Income in Oyo State, Nigeria. *The Journal of Developing Areas* 52(1): 15-28.

Ahmed, M. H., Geleta, K. M., Tazeze, A. and Andualem, E. (2017). The impact of improved maize varieties on farm productivity and wellbeing: Evidence from the east Hararghe zone of Ethiopia. *Development Studies Research* 4: 9–21.

Alabi, R. A. and Adams, O. O. (2015). The Pro-Poorness of Fertilizer Subsidy and its Implications on Food Security in Nigeria. *Work in Progress (WIP) Report Submitted to African Economic Research Consortium, Nairobi, Kenya*. 78pp.

Alia, D. Y., Diagne, A., Adegbola, P. and Kinkingninhoun, F. (2018). Distributional Impact of Agricultural Technology Adoption on Rice Farmers' Expenditure: The Case of Nerica in Benin. *Journal of African Development* 20(2): 97-109.

Angrist, J. D., Imbens, G. W. and Rubin, D. B. (1996). Identification of causal effects using instrumental variables. *Journal of the American Statistical Association* 91(434): 444-455.

Asfaw, S., Shiferaw, B., Simtowe, F. and Lipper, L. (2012). Impact of modern agricultural technologies on smallholder welfare: Evidence from Tanzania and Ethiopia. *Food Policy* 37: 283–295.

Chirwa, E. and Dorward, A. (2013) *Agricultural Input Subsidies: The Recent Malawi Experience*, Oxford: Oxford University Press. 82pp.

Diagne, A., Adékambi, S. A., Simtowe, F. P. and Biaou, G. (2009). The Impact of Agricultural Technology Adoption on Poverty: The case of NERICA rice varieties in Benin". Contributed paper presented at the 27th Conference of the International Association of Agricultural Economists. August 16-22, 2009, Beijing, China.

Diagne, A., Alia, D. Y., Amovin-Assagba, E., Wopereis, M. C., Saito, K. and Nakelse, T. (2013). Farmer perceptions of the biophysical constraints to rice production in sub-Saharan Africa, and potential impact of research. *Realizing Africa's Rice Promise* 2013: 46-68.

Dontsop Nguezet, P. M., Diagne, A., Okoruwa, V. O. and Ojehomon, V. T. (2011). Impact of Improved Rice Technology (NERICA varieties) on Income and Poverty among Rice Farming Households in Nigeria: a Local Average Treatment Effect (LATE) Approach". DLG-Verlag Frankfurt. *Quarterly Journal of International Agriculture* 50, No. 3.

Eboh, E. C., Ujah, O. C. and Amaechina, E. C. (2006). Do Government Fertiliser Subsidies Benefit Rural Poor Farmers in Nigeria? Making Sense out of Existing Data. PMMA Network Session Paper. Available online at: [http://132.203, 59] site visited on 11/09/2018.

Fadairo, O. S., Olutegbe, N. S. and Tijani, A. M. (2015). Attitude of crop farmers towards e-wallet platform of the Growth Enhancement Support Scheme for input delivery in Oke-Ogun area of Oyo state. *Agrár Informatics/Journal of Agricultural Informatics* 6(2): 62-71.

FAO. (2018). Annual statistical publication. Rome: Food and Agriculture Organization of the United Nations.

FMARD (2014). Agricultural Transformation Agenda: We Will Grow Nigeria's Agricultural Sector, Draft, Abuja, Nigeria. Computer Disk, Washington DC.

Friedlander, D. and Robins, P. K. (1997). The distributional impacts of social programs. *Evaluation Review* 21(5): 531-553.

Frölich, M. and Melly, B. (2010). Quantile treatment effects in the regression discontinuity design: process results and Gini coefficient.

Gelo, D., Koch, S. F. and Muchapondwa, E. (2013). Do the poor benefit from devolution policies? Evidences from quantile treatment effect evaluation of joint forest management. *Economic Research Southern Africa (ERSA) Working Paper*, no. *400*. 42pp.

Ikudayisi, A. A., Babatunde, A. A. and Yusuf, S. (2019). Distributional effect of income on rural farm household welfare in Nigeria: Identifying knowledge gaps and policy options. *Journal of Agriculture and Veterinary Science* 12(1): 52-58.

Issahaku, G. and Abdulai, A. (2019). Can farm households improve food and nutrition security through adoption of climate-smart practices? Empirical evidence from Northern Ghana. *Applied Economic Perspectives and Policy* 2019: 1–22.

Jayne, T. S. and Rashid, S. (2013). Input Subsidy Programs in Sub Saharan Africa: A Synthesis of Recent Evidence', *Agricultural Economics* 44(6): 547–562.

Jayne, T. S., Mather, D., Mason, N. and Ricker-Gilbert, J. (2013). How do Fertilizer Subsidy Programs Affect Total Fertilizer Use in Sub-Saharan Africa? Crowding Out, Diversion, and Benefit/Cost Assessments. *Agricultural Economics* 44(6): 687–703.

Kassie, M., Jaleta, M. and Mattei, A. (2014). Evaluating the impact of improved maize varieties on food security in rural Tanzania: Evidence from a continuous treatment approach. *Food Security* 6: 217–230.

Kassie, M., Marenya, P., Tessema, Y., Jaleta, M., Zeng, D., Erenstein, O. and Rahut, D. (2018). Measuring farm and market level economic impacts of improved maize production technologies in Ethiopia: Evidence from panel data. *Journal of Agricultural Economics* 69: 76–95.

Kassie, M., Teklewolde, H., Oclaf, E., Mot, J., Pascal, M. and Mulugetta, M. (2015). Technology Diversification: Assessing impacts on crop income and Agrochemical uses in Malawi. Paper presented at 29th International Conference of Agricultural Association of Agricultural Economics, Universita Deglistudi Di Milano, August, 8th - 14th.

Liverpool-Tasie, L. S. (2013). Do vouchers improve government fertilizer distribution? evidence from Nigeria. *Agricultural Economics* 45(4): 393–407.

Lunduka, R. W., Mateva, K. I., Magorokosho, C. and Manjeru, P. (2017). Impact of adoption of drought-tolerant maize varieties on total maize production in South Eastern Zimbabwe. *Climate and Development* 11(1): 35–46.

Manski, C. F. (2004). Measuring expectations. *Econometrica* 72(5): 1329-1376.

Mason, N. M. and Tembo, S. T. (2014). *Do input subsidies reduce poverty among smallholder farm households? Evidence from Zambia* Agricultural and Applied Economics Association (AAEA) 2014 Annual Meeting, July 27-29, 2014, Minneapolis, Minnesota.

Michael, A., Tashikalma, A. K. and Maurice, D. C. (2018). Agricultural inputs subsidy in Nigeria: An overview of the growth enhancement support scheme (GESS). *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis* 66(3): 781-789.

Mohammed, A. I. (2017). *Farm credit, farmland, farm infrastructure and agricultural output in Kano State, Nigeria: the moderating effect of murabahah finance*. Doctoral Dissertation for Award Degree of PhD. at University Utara Malaysia. 142pp.

Ogunniyi, A., Oluseyi, O. K., Adeyemi, O., Kabir, S. K. and Philips, F. (2017). Scaling up agricultural innovation for inclusive livelihood and productivity outcomes in Sub-Saharan Africa: The case of Nigeria. *African Development Review* 29(S2): 121-134.

Olagunju, K. O., Ogunniyi, A. I., Awotide, B. A., Adenuga, A. H. and Ashagidigbi, W. M. (2019). Evaluating the distributional impacts of drought-tolerant maize varieties on productivity and welfare outcomes: an instrumental variable quantile treatment effects approach. *Climate and Development* 2019: 1-11.

Olomola, A. S. (2015). Driving agricultural transformation with the power of information and communication technology: The performance of Nigeria's Growth Enhancement Support Scheme, NSSP Working Paper 30. Washington, DC: International Food Policy Research Institute. 51pp.

Otekunrin, O. A., Otekunrin, O. A., Momoh, S. and Ayinde, I. A. (2019). How far has Africa gone in achieving the zero hunger target? Evidence from Nigeria. *Global Food Security* 22: 1-12.

Ricker-Gilbert, J. (2014). Wage and employment effects of Malawi's fertilizer subsidy programme. *Agricultural Economics* 45(3): 337–353.

Ricker-Gilbert, J. and Jayne, T. S. (2012). Do Fertilizer Subsidies Boost Staple Crop Production and Reduce Poverty Across the Distribution of Smallholders in Africa? Quantile Regression Results from Malawi. Selected Paper prepared for

presentation at the International Association of Agricultural Economists (IAAE) Triennial Conference, Foz do Iguaçu, Brazil, 18-24 August, 2012.

Ricker-Gilbert, J., Jayne, T. S. and Chirwa, E. (2011). Subsidies and crowding out: A double-hurdle model of fertilizer demand in Malawi. *American Journal of Agricultural Economics* 93(1): 26-42.

Shiferaw, B., Tesfaye, K., Kassie, M., Abate, T., Prasanna, B. and Menkir, A. (2014). Managing vulnerability to drought and enhancing livelihood resilience in sub-Saharan Africa: Technological, institutional and policy options. *Weather and Climate Extremes* 3: 67–79.

Wiggins, S. and Brooks, J. 2010. The Use of Input Subsidies in Developing Countries. Global Forum on Agriculture 29-30 November 2010. Policies for Agricultural Development, Poverty Reduction and Food Security, OECD Headquarters, Paris.

Wossen, T., Abdoulaye, T., Alene, A., Feleke, S., Ricker-Gilbert, J., Manyong, V. and Awotide, B. A. (2017). Productivity and welfare effects of Nigeria's e-voucher-based input subsidy programme. *World Development* 97: 251–265.

Wossen, T., Berger, T. and Di Falco, S. (2015). Social capital, risk preference and adoption of improved farm land management practices in Ethiopia. *Agricultural Economics* 46: 81–97.

CHAPTER FIVE

5.0 Summary, Key Contribution, Conclusion, Recommendations and Areas for Further Research.

This chapter presents the summary and key contributions of the study. The chapter also discusses important policy implications and lessons drawn from the study as recommendations to relevant authorities, stakeholders, and researchers for future action. The chapter also suggests areas for further research identified as gaps from the study.

5.1 Summary of Findings

The research problem was addressed through three specific objectives using cross-sectional data. The first objective examined the impact of GESS subsidy programme on productivity of smallholder maize farmers using PSM and IV-2SLS. The result from PSM indicates that GESS increased maize yield of participants by 25% while the result from IV-2SLS method indicated that GESS significantly $(P \leq 0.01)$ increase maize yield by 37.7% after controlling for other factors, The study also found that landholding, membership of a commodity association, years of education, age of household head and household size positively influence maize productivity significantly, while distance to the market influence productivity negatively.

In the second objective, we analyzed the impact of GESS subsidy programme on welfare outcomes of the households. The study used Alkire-Foster MPI (2011) measure of poverty as a welfare indicator. By way of estimation, we employed PSM and binary logistic model with instrumental variable method to estimate the direct impact of GESS on MPI. The

result from the PSM indicates that GESS decreased households multiple deprivation within a range of 0.05 to 0.06 representing 15.6 % to 19.4% decrease depending on the matching method. Further, a result from binary logistic regression with instrumental variable method also indicates that GESS reduced the probability of households to be MPI poor by 16.8%, but the effect was statistically weak. The results also show that off-farm income and years of education significantly decreased the probability of household to be MPI poor at ($P \leq 0.05$ ¿ significance level. Overall, the findings indicate that GESS programme is effective in decreasing households multiple deprivations.

While in the last objective, we used an IV-QTE model to examine the impact of GESS on income distribution of the households. The results show heterogeneous programme impact, specifically, we found statistically significant impact of GESS at the lower tail (quantiles) than the middle and upper tails of the income distribution. This means that the impact of GESS subsidy in raising household income was better among poor farming households. Indicating that GESS is pro-poor in income.

5.2 Key Contribution of the Study

Using data from smallholder maize farmers in Kano State and various regression techniques, we analyzed the impact of GESS subsidy on maize productivity, multidimensional poverty and income distribution. The contribution to literature lies particularly in the analysis of the impact of GESS on multidimensional poverty and income distribution.

First, the application of Alkire-Foster multidimensional poverty measure indicates that GESS have direct negative impact on household multiple deprivations; this means that

when farmers' income is enhanced, households can use it to improve on other livelihood outcomes such as health, education, household assets and nutrition to enhance their quality of life. Studies that have examined the impact of interventions on multidimensional poverty are patchy and currently scanty in literature.

Secondly, the evaluation of the distributional impact of GESS subsidy on household income is another novelty of the study. We found that the impact of GESS subsidy was statistically and significantly higher at the lower tail of income distribution, suggesting that GESS decreases income inequality and is pro-poor in income. This finding has implication for effective targeting. Distributional impact of programme is hardly reported in evaluation literature.

5.3 Conclusion

The objective of this study was to examine the impact of GESS subsidy on productivity, welfare and income distribution of smallholder maize farmers in Kano State. The analysis of the impact of GESS subsidy on productivity indicates that, on average GESS increased maize yield of the farmers Kano. Moreover, landholding, membership of a commodity association; years of education, and household size were found to be maize productivity enhancing factors. Based on the findings we reject the null hypothesis and conclude that the GESS had significant impact on maize productivity.

Furthermore, the results from the impact of GESS subsidy programme on MPI shows that GESS significantly decreased the probability of a household to be MPI poor. Therefore, we have evidence that GESS subsidy contributed to household income and decrease multiple household deprivations. We found that off farm income and education levels are Poverty reducing factors.

While the results from Conditional Instrumental Variable Quantile Treatment (IV-QTE) indicated heterogeneous programme. Furthermore, we found a significantly higher programme at the lower tail than upper tail of the income distribution. This implies that GESS decreased income inequality and is pro-poor in design. Furthermore, the study found that the fraction of the poor who benefited more from the programme vary by years of education, market participation, and age of the household head and area cultivated.

5.4 Recommendations

Based on the findings of this study, the following recommendations are found to be relevant in improving the effectiveness and efficiency of GESS subsidy programme.

(i) The findings of the study indicated that membership of commodity association significantly improves productivity; it is recommended that strengthening farmers' cooperative through strong institutional support can improve farmers livelihood. An important step towards organizing non-member farmers into cooperative and other community development initiatives is necessary.

(ii) The negative effect of distance to the farm on productivity will require bringing the supply system close to the farmers or increase public investment on rural road to increase road density as distance to farm will have serious implication for agricultural productivity.

(iii) The negative relationship between extension visit and productivity suggest the need to review the design and implementation of GESS subsidy because the current design does not involve the participation of agricultural extension. The capacity of the farmers can be enhanced through positive complementary synergy that exist between input use and extension services when farmers use

according to the right knowledge on recommended usage. Moreover, as the number of educated and skilled labour in rural areas is increasing over time due to improved access to education, equipping farmers with knowledge and skills to secure good livelihood and break out of poverty is inevitable.

(iv) There is the need for further research that will inform the development of policies and programmes that will promote the growth of agriculture and rural non-farm employment.

(v) While some of indicators such as housing conditions, cooking fuel and asset ownership can easily be improved when the farmers income increases, other indicators such as access to electricity and safe drinking water may require broader infrastructural investments that are beyond the scope of individual households.

(vi) While education is important, further research should focus on the nature of education that is required to improve rural livelihood.

(v) Some descriptive results show that there were a percentage of wealthy farmers that benefited from GESS .This shows that this programme only partly achieve its objective, therefore improving the distributional outcome of GESS through effective targeting of vulnerable and marginalized groups of will increase the programmes benefits to the poor.

(Vi) There is the need for complementary policies that may consolidate the impact of GESS. For example, the synergies between GESS subsidy and social cash transfer, road infrastructure or research may result in a more effective impact of GESS in increasing productivity and household welfare for the most disadvantaged households.

5.5 Areas for Further Research

Based on the empirical analyses in this thesis, future research is suggested to focus on four research agenda.

(i) It is not certain whether the programme benefits outweighs the cost born by the government; there is the need to build on the results to estimate the overall increase in maize production as a result of GESS and to determine whether total benefit outweighs the cost. It is also necessary to find out if subsidizing fertilizers is the most cost-effective policy option when it comes to promoting agricultural productivity and farmers' welfare.

(ii) Considering the impact of GESS subsidy on the promotion and sustainability of inputs markets, there is the need to determine whether GESS input subsidy created effective demand in private input market.

(iii) An analysis of gender impact of GESS subsidy and its implication on productivity, food security and poverty reduction can be an extension of this study.

(iv) GESS input subsidy programmes enhanced agricultural productivity. However, increasing crop productivity alone is not sufficient to improve welfare of farmers; rather, farmers have to be linked with input and output markets. Therefore evaluating the impact of GESS on maize commercialization can also be an area of further research.

APPENDICES

Appendix 1.1: Survey Questionnaire

SOKOINE UNIVERSITY OF AGRICULTURE
SCHOOL OF AGRICULTURAL ECONOMICS AND BUSINESS STUDIES
DEPARTMENT OF AGRICULTURAL ECONOMICS

IMPACT OF GROWTH ENHANCEMENT SUPPORT SCHEME ON PRODUCTIVITY, WELFARE AND INCOME DISTRIBUTION OF SMALLHOLDER MAIZE FARMERS IN KANOSTATE, NIGERIA.

Ph.D. Thesis Research Project
Survey Questionnaire

Prepared By Tiri Gyang Dakyong (Ph.D. Student, Sokoine University of Agriculture, Tanzania)

General Instructions to Enumerators

Make brief introduction before starting any question, introduce yourself to the Farmers, greet them in local ways and make clear the purpose and objective of the study.Please fill the interview schedule according to the farmers reply (do not put your own opinion).

Please ask each question clearly and patiently until the Farmers gets your points.
Please do not use technical terms and do not forget local units.
During the process put the answer of each respected respondents both in the space provided and tick on choice.

Remark: The personal profile obtained from respondents with regard to the theme will be kept confidential and will not have any consequence on the respondent in any ways. Please give correct answers to the following questions.

HOUSEHOLD IDENTIFICATION

1.Enumerator's Name:_____	2.[Date/Month /Year]_____	3. Questionnaire Code:_____
4. Region: _____	5. Local government: _____	6. Village/community_____
7. Name of the survey respondent:_____ 8. Sex of the survey respondent:_____ 9. Household membership status:_____		

A: HOUSEHOLD INFORMATION

Household Member	**Relationship with Household head**	**Sex**	**Age**	**Household size**	**Education status**	**Years of farm experience**	**Number of extension visits per month**	**Access to credit**	**Marital status**
	Key: relationship to household head Head Wife Child Any	Male -1 Female -2			Koranic –1 Primary -2 Secondary -3 Tertiary -4			Yes =1 No =0	Single Married Divorce Widow/widowed

Household Member	Residential distance from plot	Nature of residence	Source of finance	Membership of organization	Main activity	Involvement in off - farm activity
.						
		Rural Urban	Self Relations and friends Commercial bank Money lenders	Yes =1 No =0	Not working – Schooling -2 Farming -3	Yes =1 No =0

B: INFORMATION ON INPUT USED

CHEMICALS

Plot	Plot size	Operation	Chemicals type	Quantity	Unit (Litres)
		Land preparation -1 1st weeding -2 2nd weeding -3 Storage -4	Herbicide -1 Pesticide -2		

SEEDS

Plot No.	Cropping system	Crop type	Seed type	Quantity	Units	Type	Quantity	Unit
	Mono cropping Mixed cropping Relay cropping Others	Sole -1 maize 2 maize /cowpea2 maize /millet -3 maize /sorghum-4 maize /soybeans	Hybrid seed Open pollinated seed Traditional /local seeds					

3. FERTILIZER USE

No. Plots	Plot size	Farm operations	Fertilizer type	Quantity	Unit
		Land preparations – 1st weeding -2 2nd weeding -3	NDK-1 Urea -2 Organic manure-3		

4. LABOUR USE

Plot	Operation	Family labour			Hired labour				Communal /exchange labour		Cost (₦)if any
		No	Days used	Adult male	Adult female	Days used	Cost of labour (₦)	No. of person hired	No. of persons	Days used	
	Land preparation										
	Fertilizer weeding application form										
	1st weeding										
	2nd weeding										
	2nd fertilizer application										
	Harvesting										
	Threshing										
	Transportation										

5. COST OF INPUTS USED

What quantity of the following purchased inputs did you used in the last farming season and what was the cost incurred?

Inputs	Quantity	Price/unit (₦)	Total Cost (₦)
Seeds (kg) 1. Open pollinated 2. Hybrid seeds 3. Local/traditional seeds			
Inorganic Fertilizer (Bags) NPK UREA			
Manure (Kg)			
Labour (mandays)			
Pesticide (Litres)			
Herbicides (Litres)			
Animal traction or tractor hiring			
Equipments (hoe, cutlass, tractor, etc)			
Others (specify) ……..			

In the table below, state the type(s) of crop and quantity produce for each type

CROPS	Quantity Harvested in Kilogram	Quantity Harvested in bag(s)	Quantity sold	Amount sold (₦) (sales)	Quantity consumed In kilogram	Quantity given out as gift (if any) in kilogram	Quantity stored In kilogram
CEREALS							
Maize							
Millet							
Sorghum							
Rice							

6: MAIZE CROP PRODUCTION

Cropping system	Crop grown	Plot size	Plot size in Hectares	Plot slope	Acquisition of plot	Type of seeds used	Plot quality
1-Sole cropping 2-Mixed cropping 3-Relay cropping 4-others	1-Maize 2 –Maize/cowpea 3-Maize/sorghum 4-Maize/cowpea/soybeans 5-others			1-Flat 2-undulating 3-Mountanous 4 -others	1-Inherited 2-Rented 3-Purchased 4 -Gift 5-Others	1-Improved seeds 2-Local seeds 3-mixture of improved and local seeds	1-Poor soil condition 2-Fertile soil condition

7: HOUSEHOLD OTHER INCOME SOURCES

1. Do you or your family under take some additional income generating activities (off Farming and non -farm activities) in the year 2016 1. Yes 2. No

2. If yes list the income earned from off -farm and non - farm activities

S/N	Non -farm income Sources of income	Number of people engaged	Number of days worked in a month	Income per working day	Total annual income from off farm activity
1	Wage				
2	Selling local drink				
3	Petty trading				
4	Selling fire wood				
5	Handicraft				
6	Herding				
7	Pension payments				
8	Ceramic				
9	Carpenter				
10	Rent from assets				
11	Trading				
12	Clothes making				
13	Hired in other farm				

8: FOOD EXPENDITURE

1. HOUSEHOLD Expenditures on Food Items in the LAST SEVEN DAYS. (Here, wife and/or person involved in purchases should be the principal respondent/s).

Item No	Food type	Own harvest/stock		Purchased			Receivable in kind, gift, aid...		
		Amount	Unit	Amount	Unit	Total expenditure	Amount	Unit	Source
1	Cereals								
1.1	Maize								
1.2	Rice								
1.3	Wheat								
1.4	Sorghum								
1.5	Other ----------								
2	Pulses								
2.1	Fababean								
2.2	Lentils								
2.3	Other ……..								
3	Oil crops --------								
4	Animal products								
4.1	Milk/cheese/butter								
4.2	Beef								
4.3	Chicken								
4.4	Eggs								
5	Coffee								
6	Sugar								
7	Salt								
8	Cooking oil								
9	Spices (pepper)								
10	Vegetables and root crops								
10.1	Potatoes								
10.2	Green leaf								
10.3	Sweet potato								
12	Stimulants and alcohols								
12.1	Chat								
12.3	Araqi								
13	Others ----------								

9: HOUSEHOLD NON-FOOD EXPENDITURE IN THE LAST ONE MONTH

ITEMS	AMOUNT(N)
Clothing (fabrics, clothes, towels, beddings)	
Shoes, foot and wears	
Education (fees, books, school uniform)	
Health (health, medicine, glasses, doctors charges	
Transportation cost	
Handset and GSM recharge card	
House rent	
Furniture (beds, tables and chairs)	
Kitchen utensils (pot, cup, plate's spoons etc)	
Cigarettes or tobacco or kolanut	
Recreational (cinemas, video/DVD rentals	
Petrol and engine oil, kerosene, charcoal. Firewood. gas, candle	
Electricity bills including purchase of light bulbs	
Purchase of motor cycle/bicycle	
Home repairs (painting, roofing).	
Debt repayment (cooperative, local contribution).	
Ceremony and entertainment (wedding, naming, funeral etc).	
Donations to religious activities, alms, offering. Charity).	
Other taxes and levies (community levies, night guards)	
Other taxes and levies (community levies, night guards)	
Other specify	

10: HOUSEHOLD ASSETS

Average productive asset values

Asset Name	Number of items owned	When did the last purchase made by the household ?	Average per unit price during the last purchase (Naira)
Ox-cart or Horse –cart			
Generator			
Machetes/Sickle			
Axe/ Hoes			
Spade			
Computer and accessories			
Sprayer			
Wheel barrow			
Refrigerator			
Sewing machine			
Bicycle			
Tractor			
Other motorized vehicles			
Radio/radio cassette			
Mobile phone			
Television			
Other, specify			

11: THE E-WALLET SCHEME

1 .Are you aware of GESS program ?

2. What is your source of information?

registered in the E-wallet scheme? If yes since when? ----------

2. How did you register? ----------

12: FERTILIZER

4 Rate your access to fertilizer through the scheme

Satisfactory B. Not satisfactory C. no difference

5. Is there any change in the rate of fertilizer (kg/plot) application as a result of the fertilizer subsidy programme? A Yes B. No

6. If yes indicate the following

Fertilizer Type/bag	2012	2013	2014	2015	2016	Total Quantity/bag
NPK						
UREA						
T0TAL						

Are you able to acquire all the fertilizer you needed through the scheme?

Indicate the following in the table below

Cropping type	Rate of fertilizer application before before subsidy kg/plot	Rate of application after subsidy kg/plot	Output before subsidy kg/plot	Output after subsidy Kg/plot
Maize only				
Maize/cowpea				
Maize/millet				
Maize/sorhum				
Others specify				

13: IMPROVED MAIZE SEEDS

Estimate the quantity of seeds you received during the subsidy scheme

Seed type	2012	2013	2014	2015	2016	Quantity kg

5. Are you able to acquire all the fertilizer and seeds through the scheme?.....
.....
6. Does the scheme make access to fertilizer easier? Yes ( ), No ( )
7. Was there the presence of middlemen in the distribution of the inputs……
8. Mention some challenges in accessing fertilizer under the scheme……
…….
9. If you did not participate in the scheme what were your reasons
……
……

10. Suggest some ways you think the government can improve the performance of the scheme……
……
……

11. Do you experience some shocks?.....

12. Mention some few
……
……

13.What is the intensity ?(severe , mild , chronic ,acute)
……

14. Mention some benefits you have derived from this program since inception ,if any?
……
……

15. What do you know about the prices of fertilizer in the last two years (I increase ii decrease iii unchanged)
……
……..

16.What do you know about the prices of improved maize seeds in the last 2 years
……
……

17. What is the price of maize in the last two years
……

i increase ii. Decrease iii unchanged

18. Which crop do you grow more? And why ?.....

19 Do you think growing maize is profitable?
……

20. What is the main use of crops you produce? i.consumption ii. Sell
……

20. If not profitable why do you grow maize more than other crops
……
……

21. Do you have access to input and output market?
……

22.What is you means of transportation ?
……

23. What is your means of communication ?.....
.....

24. What is the average distance in kilometre from your village to input market?
……
……

25. What is the average distance from your village to produce market?
……
……

14. **FOOD SECURITY ASSESSMENT**

What is your understanding of food security/insecurity?
……
……
……
……
When do you consider a household to be food secure?
.....
.....
.....
What are less preferred foods in your area(food consumed in times of less food/hunger)
……
……
……
What are the considered best foods in your area? (food you eat during harvest season)
.....
.....
.....
Which months do you have more foods (harvest)
……
……
Which ones are the food scarce months?
……
……
What do people normally do at times of less food to cope with the situation? Mention as many strategies as possible used in your area
…….
…….
……
……
Which foods do you consider inferior i.e. consumed when there is food scarcity in your area?.....
.....
.....
Would you normally eat this food during the harvest season?
……..……. ……

Appendix 2.1: Result from logistic regression estimates of the propensity score

GESS Participant=1	Coeff.	Std.Err	z- value.	Marginal effect
Household land holding	0.051	0.10	0.54	0.58
Own phone	0.15 **	0.07	2.64	0.20
Household Size	0.09**	0.04	2.25	0.03
Marital status	0.28	0.31	0.88	0.37
Age of households head	0.01	0.01	1.00	0.62
Gender of household head	-0.33	0.30	-1.11	-0.26
Member of commodity association	- 0.34**	0.15	-2.26	-0.05
Number of extension visits per month	0.24**	0.12	2.02	0.03
Years of farming experience	0.02	.013	2.08	0.03
Access to credit	0.15	0.22	0.64	0.52
Years of formal education	0.05**	0.02	2.50	0.10
Available labour	0.11**	0.05	2.2	0.22
Distance to nearest redemption Centre	-0.62***	0.10	-6.13	-0.11
_cons	0.06	1.01	0.07	0.94
	3.65***	0.18	4.50	0.00
N	390			

Log likelihood = -205.73, LR chi2 (12) = 82.77; Prob> chi2 = 0.0001; Pseudo R^2= 0.22; Note: significant levels * 1%, ** 10%, and *** 1%

Appendix 2.2: Distribution of propensity scores by participation status

Groups	Obs.	Mean	Std. Dev.	Min	Max
Total Household	390	0.43	0.22	0.03	0.98
Treatment households	170	0.53	0.21	0.04	0.99
Control households	220	0.34	0.17	0.03	0.81

Appendix 2.3: Results of the balancing tests of covariates using the Kernel band with 0.01 matching estimator

Variable	Unmatched Match	Treated	Control	%bias	%reduction bias	t-test t	p>(t)	V(T)/V/C
P score	U	0.56718	0.33445	112.9		11.1	0.00	1.39*
	M	0.5164	0.51604	0.2	99.8	7	0	1.00
						0.02	0.98	
							8	
Household	U	3.6706	3.525			1.20	0.22	1.28
Landholding	M	3.6454	3.6703	82.9	82.9	-0.18	9	1.19
							0.85	
							8	
Phone Number	U	0.84706	0.64091	48.5		4.67	0.00	
	M	0.8156	0.7974	4.3	91.2	0.37	0	
							0.70	
							0	
Household Size	U	13.341	11.609	37.2		3.56	0.00	0.45*
	M	13156	14.274	-24.0	35.4	-1.95	0	0.36*
							0.05	
							5	
Marital Status	U	0.87059	0.82727	12.1		1.17	0.24	
	M	0.86525	0.81485	14.1	-16.4	1.15	1	
							0250	
Age of	U	45.765	46.15	-4.0		-0.39	0.69	0.95
Household	M	46.461	47.233	-8.0	-100	-0.65	4	0.80
Head							0.51	
							6	
Gender of	U	0.8000	0.85500	-13.2		-1.30	0.19	
Household	M	0.82979	0.8697	-10.5	20.2	-0.94	5	
Head							0.35	
							0	
Membership of	U	0.54118	0.58636	-9.1		-0.89	0.37	
Commodity	M	0.56028	0.57573	-3.1	65.8	-0.26	3	
Association							0.79	
							4	
Number of	U	1.8765	1.6727	21.4		2.09	0.03	0.91
Extension Visit	M	1.8440	1.9746	-13.7	359	-1.13	8	0.92
/Month							0.25	
							9	
Years of	U	26.541	27.000	-4.9		-0.48	0.63	0.81
Farming	M	26.61	26.0480	6.0	-23.5	0.54	4	1.14
Experience							0.58	
							9	

Distance to	U	2.5647	3.4523	-11.2		-7.18	0.00	2.65*
Redemption	M	2.8156	2.9761	-12.9	81.9	-1.01	0	1.66*
Centre							0.31	
							5	
Household	U	0.6000	0.64091	-8.4		-0.83	0.41	
Access to	M	0.56028	0.5448	3.2	62.2	3.2	0	
Credit							0.79	
							6	
Years of	U	13.635	12.895	20.7		2.02	0.04	0.88
Education	M	13.496	13.548	-1.4	93.1	-0.12	4	0.91
							0.90	
							5	

Appendix 2.4: Validity check for the Instruments: Dependent variable: Maize yield (kg/ha).

Variable	Coeff.	Standard error.	t-value
Number of years of residence	2.21	2.27	0.97
Membership of ruling political party	0.19	0.14	0.89

Appendix 3.1: Table B: Adult-equivalent conversion factors for estimated calorie requirements according to age and gender

Age (years)	Calories (kcal)	Adult-equivalent
Newborns		
0-1	750	0.29
Children		
1-3	1300	0.51
4-6	1800	0.71
7-10	2000	0.78
Men		
11-14	2500	0.98
15-18	3000	1.18
19-24**	2900	1.14
25-50	2900	1.14
51 and above	2300	0.90
Women		
11-14	2200	0.86
15-18	2200	0.86

19-24	2200	0.86
25-50	2200	0.86
51 and above	1900	0.75

****** is used as the reference mean adult calorie requirement
Source: Claro *et al*. (2010)

Appendix 3.2: Conversion factor for computation of Adult Equivalent

Age group(Years)	**Male**	**Female**
¿10	0.60	0.60
11−13	0.90	0.80
14−16	1	0.75
17−50	1	0.75
¿50	1	0.70

Source: Storck *et.al.*,1991

Appendix 3.3: Distribution of propensity scores by participation status

Groups	Obs.	Mean	Std. Dev.	Min	Max
Total Household	390	0.43	0.22	0.03	0.98
Treatment households	170	0.53	0.21	0.04	0.99
Control households	220	0.34	0.17	0.03	0.81

Source: Authors calculation,2020

Appendix 3.4: Covariate balancing test before and after matching

Matching Algorithm	Pseudo R^2		LR $X^2(P-value$ $X^2(P-value$)		$P > chi^2$		Standardize mean bias		Total % bias reduction
	Before	After	Before	After	Before	After	Before matching	After matching	
NNM	0.219	0.047	92.1	10.11	0.001	0.332	26.3	7.3	56.7
KBM	0.213	0.023	108.2	8.88	0.000	0.782	26.4	6.1	86.2
RCM	0.219	0.017	101	11.21	0.003	0.413	26.9	6.7	58.1

NNM = one nearest neighbor matching and common support, KBM= Kernel matching with bandwidth 0.01 and common support, RCM= Radius caliper 0.01 matching

Appendix 3.5: Share of households deprivations in terms of MPI indicators

Indicators	Full sample	GESS participants	Non-participants	Mean difference
Years of schooling	0.126	0.129	0.126	0.003
Child school attendance	0.327	0.128	0.126	0.002
Food availability	0.223	0.264	0.362	-0.102**
Nutrition	0.472	0.269	0.474	-0.105*
Asset ownership	0.440	0.393	0.303	0.090*
Sanitation	0.429	0.427	0.631	-0.216***
Drinking water	0.528	0.597	0.628	-0.030
Floor	0.328	0.427	0. 529	-0.102**
Electricity	0.600	0.688	0.729	-0.041
Cooking fuel	0.528	0.540	0.790	-0.250***
Total	390	170	220	

Appendix 3.6: Impact of income variables on MPI and MPI intensity

Income variables	Multidimensional poverty head count (0 1)		MPI (0 1)		MPI intensity (0-1)	
	Coefficient	Standard error	Coefficient	Standard error	Coefficient	Standard error
Crop income	-0.011	0.006*	-0.128**	0.060	-0.087***	0.025*
Farm income	-0.122	0.050**	-0.240***	0.091	-0.202***	0.080
Non-farm income	-0.008	0.005*	-0.216**	0.011	-0.071*	0.040
Total income	-0.109	0.056*	-0.237**	0.098	-0.180***	0.060
Per capita income	-0.191	0.080**	-0.017**	0.007	-0.007*	0.004
Constant	4.005		5.113		4.671	

Observations	390		390		390	
Log-pesudo likelihood	-107.78		-123.10		-136.22	

Appendix 4.1: Estimation of household income of the sampled population

Variable	Full sample	GESS participants	Non-participant	Mean diff
Value of Maize produced	134 900 (37 000)	150 350 (78 900)	122 900 (68 400)	27 497**
Value of other crops	187 700 (101 230)	200 367 (129 000)	220 000 (104 500)	-19 633**
Value of livestock	20 890.90 (3500)	34 500 (6500)	31 750 (7900)	2750
Total value of production	343 491 (109 800)	385 218 (137 800)	371 651 (189 000)	13 566**
Cost of fertilizer	9700.00 (1200)	10 734 (5600)	19 690 (6780)	-8956*
Cost of pesticides	35 000 (3000)	4000 (1900)	4500 (1000)	500
Cost of transportation	5480.50 (2900)	6500 (3560)	6800 (3450)	300
Cost of labour of all farm operations	63 000 (23900.56)	52 000 (34 900)	51 000 (26 790)	1000
Total cost of production	82 080	69 345	81 990	-12 6145**
Total farm income	261 310 (97 000)	315 873 (19 569)	289 661 (180 900)	26 211**
Total non-farm	180 189 (109 000)	126 919 (69 000)	144 780 (97 000)	8449
Total household income	441 500 (235 600)	442 792 (198 670)	446 442 (230 000)	3650**
Income per capita	36 791 (9000)	26 780 (24 000)	22 341 (13 000)	4679*

Significant at 10%, 5%, and 1% level, respectively. *Notes*: Standard deviations are shown in parentheses. All values are in Nigerian naira (#), 1USD= #360.00 as at 2017 exchange rate.